AMERICAN ENGINEER AND RAILROAD JOURNAL.

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Table of Contents will be found on page 158.

VAUCLAIN FAST PASSENGER COMPOUND LOCOMOTIVES.

Atlantic Type.

Chicago, Burlington & Quincy Railroad.

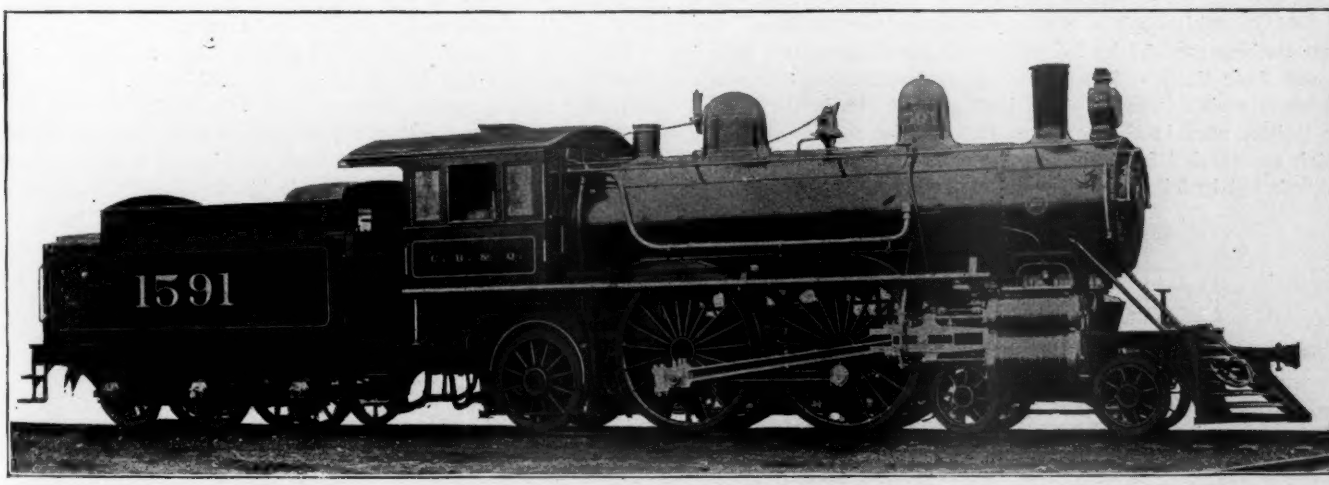
It has been known for some time that the Baldwin Locomotive Works were building new fast passenger locomotives for the fast mail trains between Chicago and Omaha. We are now enabled to print an engraving from a photograph and the chief characteristics of the design.

The Baldwin compounds built for the exacting passenger service on the Chicago, Milwaukee & St. Paul, between Chicago and Milwaukee (see "American Engineer," August, 1896, page 170), were considered exceedingly powerful engines, and it is well known that they have made good records, but the new Burlington engines are much more powerful and a great deal more may be expected from them in service. This design is especially interesting at this time because of the unusual attention which has been attracted to the subject of powerful passenger locomotives by the records of the Atlantic City service on the Philadelphia & Reading, and the data from the Purdue University model. The heating surface of the C. M. & St. P. engines, 2,244 square feet, is mentioned because, at the time, it was considered specially large, but that of the new Burlington design is 2,510 square feet, exceeding that of the C. M. & St. P. engines by 266 square feet.

The grate area of the Burlington engines is 33.6 square feet, and the firebox is 120 by 40 inches. It is 74 inches deep in front and 70 inches deep at the back. The tubes are unusually long, 16 feet, and it is noteworthy that they are 2¼ inches in diameter and but 248 in number. The cylinders are 13½ and 23 by 26 inches, which, we believe, are the largest that have been built for fast passenger engines of this type. Those of the Atlantic City engines of the Philadelphia & Reading, and also of the C., M. & St. P. engines, are 13 and 22 by 26 inches. The Burlington engines have 84½-inch driving wheels, which, with the high steam pressure, large cylinders and large boiler, will make a good combination, particularly in service where comparatively long runs are made between stops.

The weight of this engine, 159,050, has been exceeded by several of the 10-wheel type now used in passenger service, but is not by any engine with four driving wheels of which we have record. The engine presents a very attractive appearance and the performance will be watched with a great deal of interest, especially because of the prominence given to this type in recent discussions. The tender is carried on three axles. ɪne chief dimensions are as follows:

Cylinders.	
Diameter high pressure	13½ inches
" low "	23 inches
Stroke	26 inches
Valve	Balanced piston
Boiler.	
Diameter	62 inches
Thickness of sheets	11/16 inches
Working pressure	210 pounds
Fuel	Soft coal
Firebox.	
Material	Steel
Length	120 inches
Width	40⅝ inches
Depth	Front, 74½ inches; back, 70½ inches
Thickness of sheets, sides	⅜ inch
" " " back	⅜ inch
" " " crown	½ inch
" " " tube	½ inch
Tubes.	
Number	248
Diameter	2¼ inches
Length	16 feet
Heating Surface.	
Firebox	186 square feet
Tubes	2,324 square feet
Total	2,510 square feet
Grate area	33.6 square feet
Driving Wheels.	
Diameter outside	84 inches
Diameter of center	78 inches
Journals	8½ inches by 12 inches
Engine Truck Wheels.	
Diameter	36 inches
Journals	5½ inches by 10 inches
Trailing Wheels.	
Diameter	54¼ inches
Journals	8½ inches by 12 inches
Wheel Base.	
Driving	7 feet 6 inches
Rigid	15 feet
Total engine	27 feet 1 inch
Total Wheel Base of Engine and Tender	51 ft. ¾ in.
Weight.	
On drivers, about	85,850 pounds
On truck, "	40,200 pounds
On trailing wheels	33,000 pounds
Total engine "	159,050 pounds
Tender.	
Diameter of wheels	42¼ inches
Journals	6¼ inches by 10 inches
Tank capacity	5,000 gallons



Vauclain High Speed Passenger Locomotive.
Chicago, Burlington & Quincy Railroad.

BALDWIN LOCOMOTIVE WORKS, *Builders*. MR. F. A. DELANO, *Superintendent of Motive Power.*

The Great Northern Railway elevator at West Superior, Wis., is to be the largest in the world. It will be built of steel at a cost of more than $2,000,000, and the first contracts have already been let. The capacity is to be 6,500,000 bushels, or an increase of 2,500,000 more than the largest existing elevator. The date of completion is placed at the first of next year.

80,000-POUND, 35-FOOT, COAL CARS.

Lake Shore & Michigan Southern Ry.

Mr. A. M. Waitt, General Master Car Builder, Lake Shore & Michigan Southern Railway, has kindly furnished drawings of a new design for drop bottom coal cars of the gondola type for a capacity of 80,000 lbs.

The design follows the general lines adopted last year for cars of 60,000 lbs. capacity ("American Engineer," June, 1898, page 184), and a comparison of the two gives evidence of a systematic effort to secure the advantages of uniformity without, however, sacrificing important features for that purpose. The following are the general dimensions:

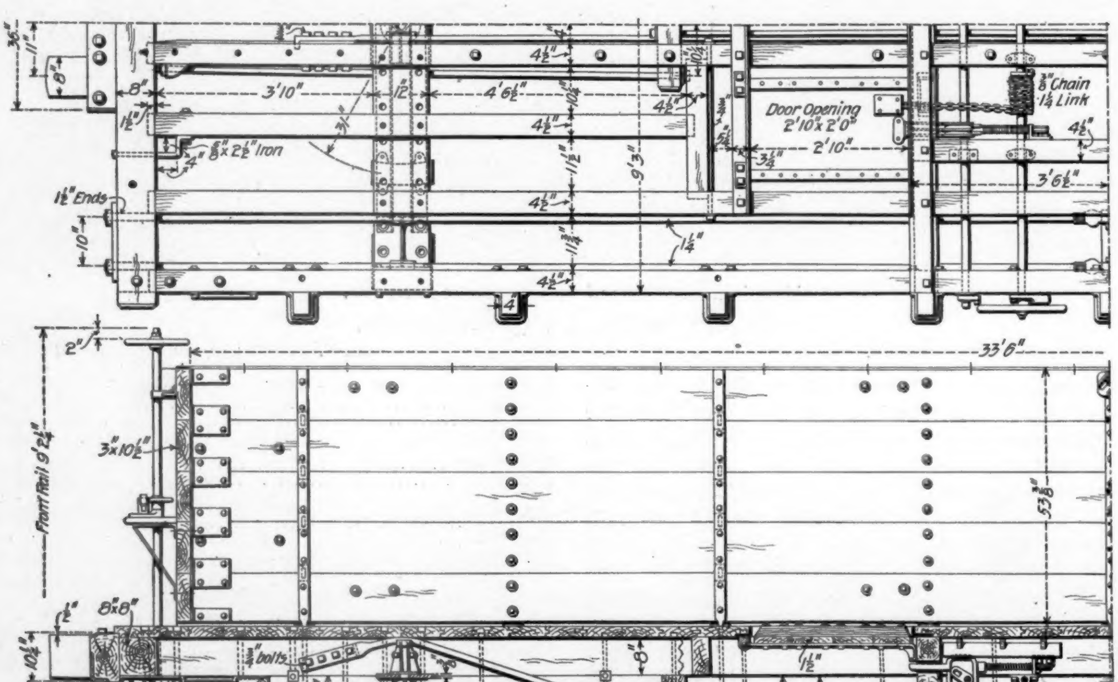
General Dimensions.

Length, over end sills	35 ft.	0 in.
Length, inside of box	33 ft.	6 in.
Width, over side sills	9 ft.	3 in.
Width, inside of box	8 ft.	9 in.
Height, top of rail to top of box	8 ft.	6⅞ in.
Height, over all	9 ft.	2¼ in.
Height to bottom of sills at ends	3 ft.	3¼ in.
Height of box, inside	4 ft.	5⅝ in.
Door openings, length	2 ft.	10 in.
Door openings, width	2 ft.	0 in.

The sills are 8 in number. The side sills are 4½ by 12 in., the same section as those for the 60,000 lbs. cars, and of yellow pine. The two center floor timbers, the two long intermediate floor timbers and the eight short intermediate floor timbers, including the short ones over the needle beams, are all 4½ by 8 in. in section and all of yellow pine. The end sills are 8 by 8 in. of white oak and the two cross tie timbers are of the same material, 5 by 12 in. section. The wooden buffer blocks are of 6 by 10¼ in. white oak, carrying malleable iron buffers. The draft timbers are of 5 by 7½ white oak abutting against 5 by 5 in. sub floor timbers forming a continuous system to sustain the compressive stresses. The draft gear is similar to that of the lighter cars in the arrangement for the pulling stresses, which are carried from the outside drawbar lugs by means of two rods to 5 by 5 inch white oak draft rod cross timbers, located just outside of the drop doors, and these two timbers are connected by means of two one inch rods with ends enlarged to 1¼ in., lying between the center floor timbers, and therefore between the drop doors. The spacing of the floor timbers is shown in the plan view of the car, which also illustrates the construction of the drop door frames and the continuous draft connections.

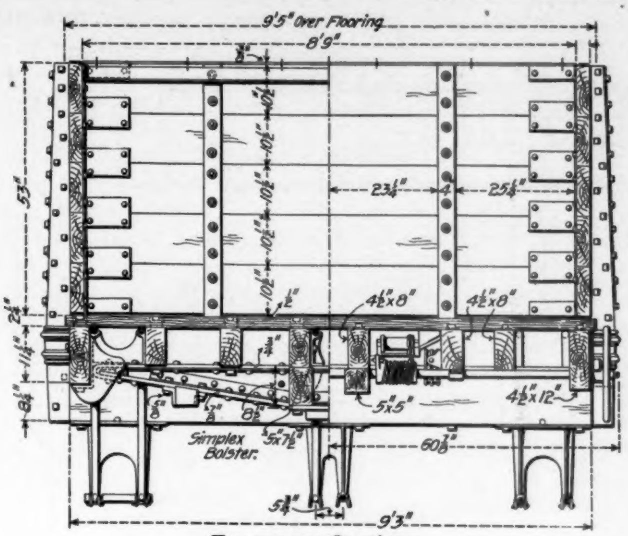
The body truss rods are six in number and are of 1¼-in. iron enlarged to 1½ in. at the ends and connected together at the center by wrought iron turnbuckles made by the Cleveland City Forge & Iron Co. The grouping of the rods is shown in the end and sectional views of the car. It is evident that they must be kept clear of the drop doors, which necessitated placing two of them at each side of the car, near the ends of the cross-tie timbers, while two others are placed at 5¾-inch centers at the center of the car and between the center sills. The outside truss rods pass through the end sills over bracket castings supported on the ends of the bolsters and then under malleable iron bearings 14¾ inches deep below the bottom faces of the cross-tie timbers, which makes the depth of the truss 34¾ inches below the upper faces of the sills, and gives a good trussing effect for the load to be handled, wtih a low fiber stress on the rods. The inner truss rods are like the outer ones, except that at the ends, where, after passing over the malleable iron brackets, which rest on the top of the body bolster, they terminate in ends flattened to 1 by 2½-inch rectangular sections, 15 inches in length, with lips on the extreme ends, and these terminals are anchored to the inside faces of the center sills by means of 4 ¾-inch bolts to each rod. To make this anchorage more secure a wrought iron plate by ½ by 2½ by 11½ inches with a lip ½-inch deep is placed under each end of each rod.

The Gould M. C. B. standard coupler is used with the M. C. B. drawbar strap. The draft springs are double, the outside coil being 5½ inches outside diameter and 8 inches high of 1⅛-inch bar, while the inner coil is 3⅛ inches outside diameter and of ⅝-inch steel. The capacity of each double coil is about 16,000 pounds. The draft arms, also made by the Gould Coupler Co.,



80,000 Pound, 35 Foot Coal Cars.—Lake Shore & Michigan Southern Railway.

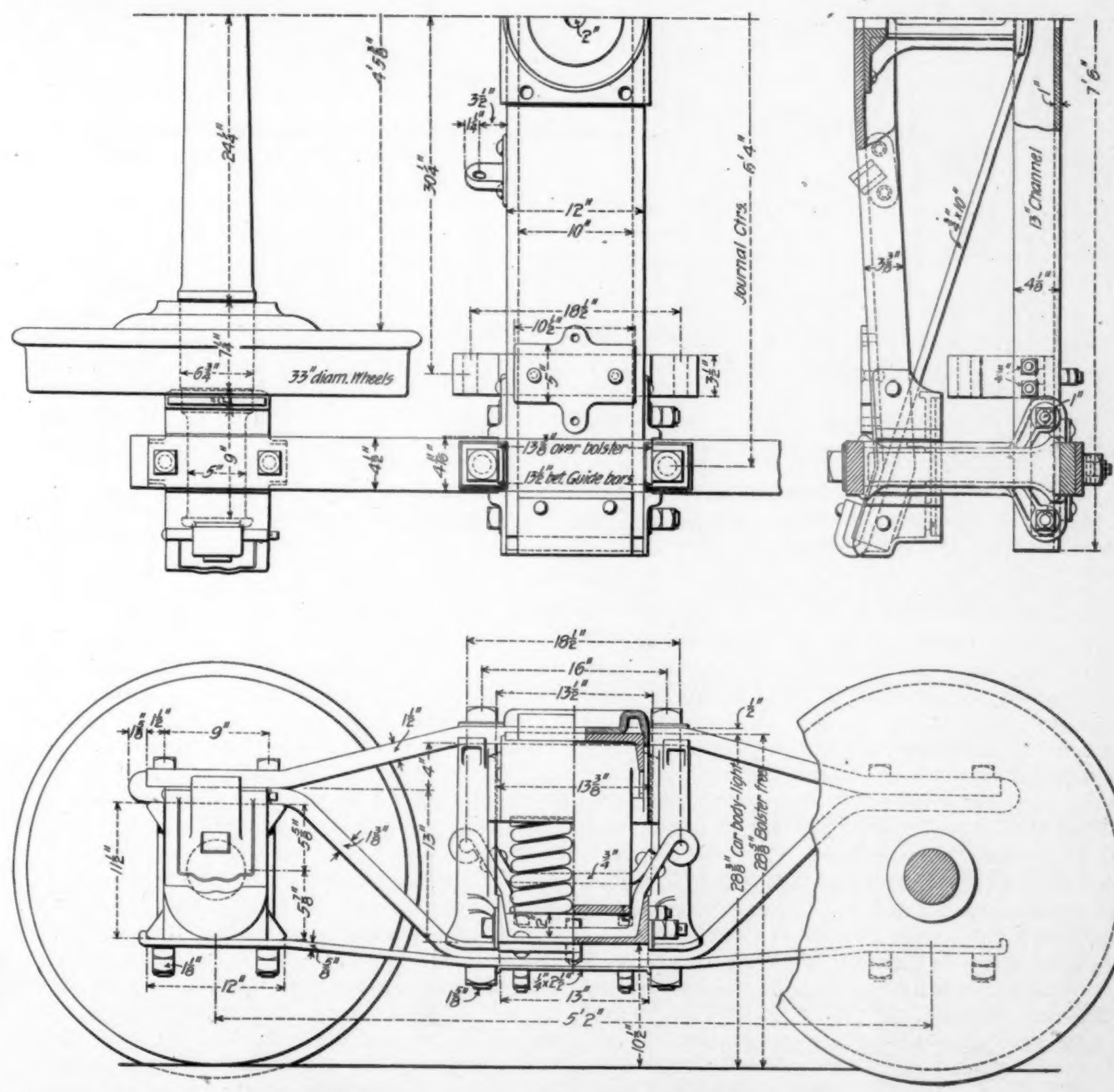
A. M. Waitt, *General Master Car Builder.*



Transverse Sections.

planks, tongued and grooved, and made flush with the top of the floor when closed. Two sides of each drop door opening are formed with angle irons, as indicated in the drawings. The unlocking and door closing devices are similar to those which we have already illustrated. The cars have 8 auxiliary stake pockets on each side of the car and 2 stake pockets for each stake. The brakes are Westinghouse. The sides of the car body are tied to gether at the center by 1¼-inch tie rod, passing through angle strut castings.

The body bolsters are located 5 feet from the outside ends of the sills and are of the Simplex type, the form of which is indicated in the engraving. The ends of the body bolsters are provided with malleable bracket vastings bolted to the side sills and having a shelf passing under and bolted to the lower faces of these sills, the bracket castings also acting as saddles for the body truss rods. This location of the two truss rods at the outer ends of the bolster imposes severe stresses, which make a stiff bolster absolutely necessary. The side bearings are of cast

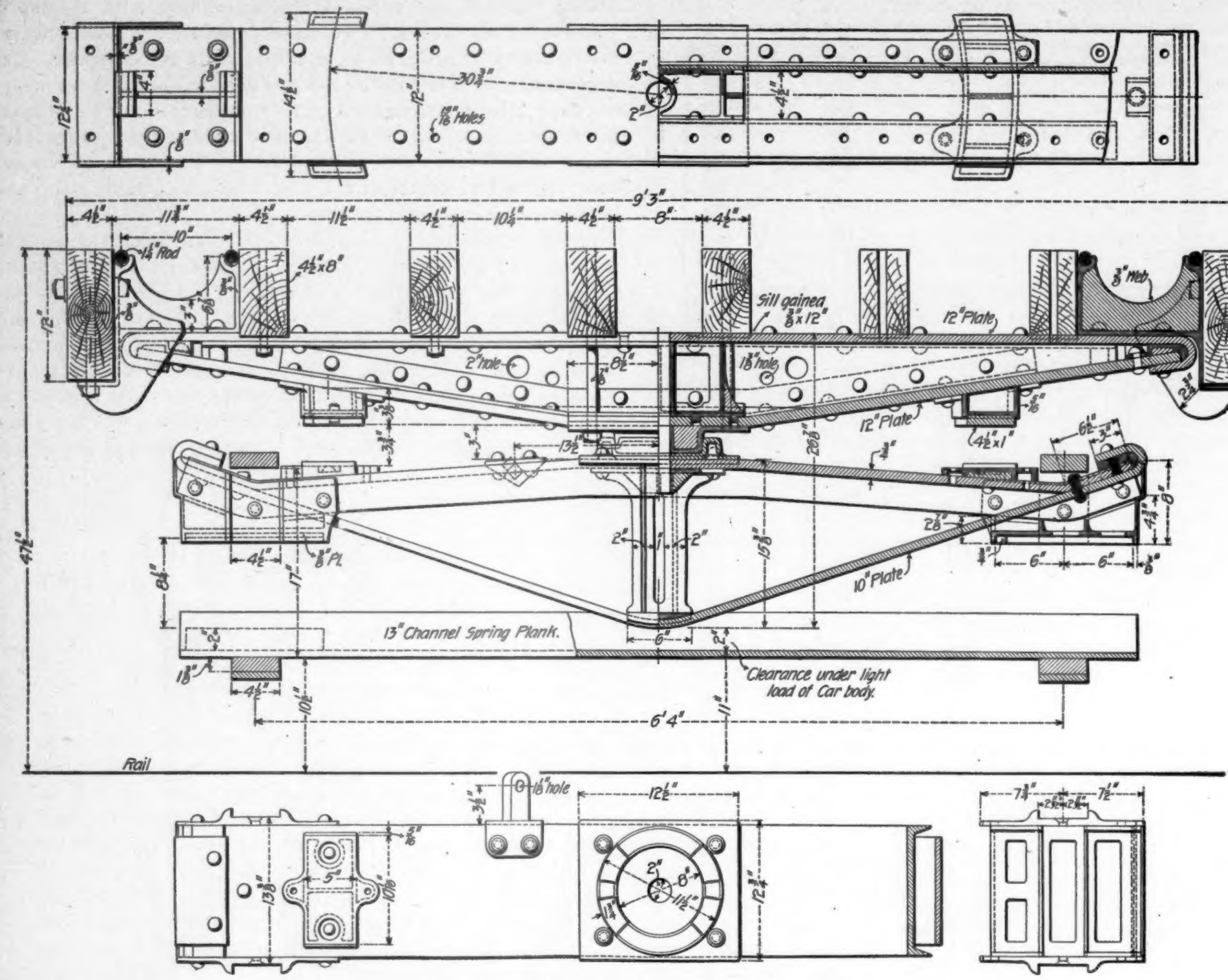


80,000-Pound, 35-Foot Coal Cars—L. S. & M. S. Ry.
Truck and Bolster Construction.

are of malleable iron with end caps. They are spaced to give a pocket 12 inches wide for the follower plates and are flush with the outside edges of the wooden buffer blocks. Extending from the draft arm to the web of the bolster a 7½ by 5-inch white oak timber is fitted beneath each center sill.

The flooring, of which there is an area of 231 square feet, is of long leaf yellow pine, 2¼ inches thick, and from 6 to 10 inches in width. The drop doors are of double thickness of iron with chilled faces and are bolted to the body bolsters. The center plates are of pressed steel.

The trucks are of the diamond type with Simplex steel truck bolsters and channel spring planks. The top arch bars are 4½ by 1½ inches, while the inverted bars are 4½ by 1⅜ inches, and the tie-bar is 4½ by ⅝ inches, the bending of the bars being to large radii. The spring plank is a 13-inch channel with 4⅛-inch flanges, the flanges being upward. The bolster guide bars



80,000-Pound Coal Cars L. S. & M. S. Railway.
Simplex Body and Truck Bolsters.

are malleable iron with palms at the bottoms to give room for two bolts in the attachment to the spring plank. The journal boxes are the M. C. B. standard for the same capacity and of the McCord type with malleable iron lids and Harrison dust guards. The boxes are packed with "Perfection Journal Box Packing."

The axles are the M. C. B. standard for 80,000-lb. cars. The specifications required open hearth steel having not to exceed 0.04 per cent. of phosphorous, 0.04 per cent. of sulphur, not more than 0.35 per cent. or less than 0.3 per cent. of carbon, and not more than 0.6 per cent. of manganese. The axles are to be tested under a drop of 1,640 lbs. with cast iron supports, having 6-inch bearing surfaces, spaced at 3 feet centers and must not crack or break under 5 blows from a height of 40 fet.

The wheels are 33 inches in diameter, weighing 650 lbs., and the wheel base of the truck is 5 feet 2 inches. The Lake Shore & Michigan Southern has ordered 500 of these cars and the Pittsburgh & Lake Erie has ordered the same number.

A NEW AND INTERESTING ENGLISH LOCOMOTIVE.

Lancashire & Yorkshire Railway.

In a new design of fast passenger locomotive, by Mr. J. A. F. Aspinall of the Lancashire & Yorkshire Railway, illustrated in "The Engineer," we find a number of interesting and novel improvements. This engine is noteworthy for the additional reason of being built up to the present limitations in regard to size; that is to say, no larger engine can be run on an English railroad. It is possible to extend the length, but not the width or height. The engine may appear enormous, as compared with others in England, but it looks small enough when compared with the new Schenectady, fast mail engine on the Chicago & Northwestern, and the corresponding Baldwin engines for the Chicago, Burlington & Quincy.

The Lancashire & Yorkshire engine is the Atlantic type in regard to the wheels, but with inside cylinders 19 by 26 inches, and steam jacketed, the jacket supply of steam being apparently controlled from the cab. The Joy valve motion is used. The driving wheels are 87 inches in diameter. The boiler is 64 inches in diameter and unusually long, the tubes being 15 feet long. The heating surface is 2,052 square feet and the grate area 26 square feet. The smoke-box is extended and is unusually long, but the extension is to the rear, and the front tube sheet is carried back into the barrel of the boiler, a peculiar arrangement, probably used for the sake of appearance. The firebox has direct stays. The total height over the stack is 13 feet 5½ inches, and the total width is 8 feet 8 inches.

The back head of the boiler is flanged outwards instead of inwards, and both ends of the rivets are exposed, which is very convenient for machine riveting. We note, also, a novelty in the driving spring rigging, the weight comes upon a bell crank under each driving box, and while the horizontal arms of these cranks transmit their loads to the spring, the vertical arms on each side are connected by a tension rod, which acts as an equalizer and is very much lighter in weight than our forms of equalizers.

The purpose of this design is to secure sufficient power in one engine to insure against the necessity for double-heading in providing for increased demands imposed by heavier cars.

LOCOMOTIVE DESIGN—THE WORKING STRENGTH OF MATERIALS.

By F. J. Cole, Mechanical Engineer, Rogers' Locomotive Works.

Spring Hangers and Equalizers.

If a record is kept of the breakages of locomotive parts, where the number of engines in actual service on the railroad is sufficiently large to include all sorts, conditions and ages of locomotives, it will be found that the percentage of broken spring hangers and spring rigging is very large. No apology seems necessary for the following suggestions, and perhaps in some cases, elementary remarks regarding the strength of these parts, if they are the means of lessening, even in a small degree, the frequency of engine failures caused by the breakages of these parts.

A spring hanger is a simple thing, not at all complex in its design, manufacture or functions. The calculation of its size for the weight it has to carry is only the work of a few minutes, provided the working stress per square inch of section is known. Actual practice (deduced from breakage) indicates that the range of working stress is from 3,500 to 4,500 pounds per square inch for good wrought iron. The maximum 4,500 pounds should never be exceeded, if breakdowns and failures are to be prevented. For exceptionally good iron the higher figures, 4,500 pounds, may be used, but for ordinarily good material, to insure freedom from breakages, the stress should be limited to 4,000 pounds.

The theoretical reason for this low working stress is not entirely clear, although it can be partly accounted for by the fact that the static load is largely increased by impact caused by the vertical motion of the driving box and the jolting or uneven movement of the engine. This, however, is not felt in its full force, as it is conveyed or transmitted to the hangers through the elastic medium of the springs. With long half elliptic springs, composed of many narrow plates, there is a tendency to wear unevenly and bend the hangers sideways. This occurs when the engine has been in service for some time, the spring bands or the saddles wearing more on one side than the other, causing the spring rigging to be thrown out of line. But bearing in mind the fact that the impact, vibration or concussion is transferred through the springs, its effect must be greatly modified and reduced before the hangers are reached. If the pull on the hangers was always directly in line with their centers, a much higher stress could no doubt be used. The fact that spring hangers do not always, or in fact usually, break through the key ways indicates that some other force than that acting directly in line with their centers. bends or twists it and throws upon them an eccentric or side bending stress, causing their rupture at a comparatively low figure. In this connection it should be remembered that it is not usually practicable to make all hangers straight, without some form of enlargement, fork or other device at the lower end.

The straight form is shown in Fig. 1, in which the strength of the material is not impaired in any way, the gibs at the top and bottom being free to move sideways, so that no side strain is apt to be produced, as the gibs rock in slots and preserve a center bearing. The form with a head on the lower end, shown in Fig. 2, is used when the clearance below the equalizer is limited. It is a convenient and customary style on account of its wide bearing on the lower end, not cutting into the equalizer face, and it suitability for use when the space is limited. In this style the iron may be injured in upsetting or the bearing not being uniform on both sides, causes a bending stress to occur, which is liable to start a crack at the shoulder. To straddle the frame, the forms shown in Figs. 3 and 4 are commonly used. The uppper part of the fork at A should be made much heavier than at B to prevent springing and breaking. The pin connection, Fig. 4, is a stronger construction, but more expensive to maintain on account of greater number of wearing parts. From Table No. 1 the proper size of spring hangers and equalizer posts may be selected. It is calculated for round-edged iron, the working stress being taken through the keyway slot for the minimum section.


Fig. 1.

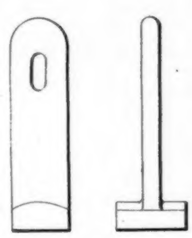


Fig. 2.

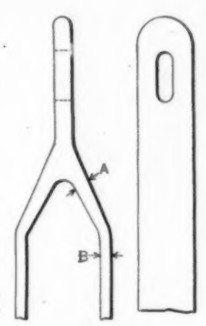


Fig. 3.

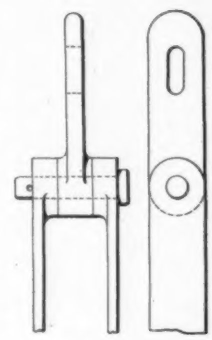


Fig. 4.

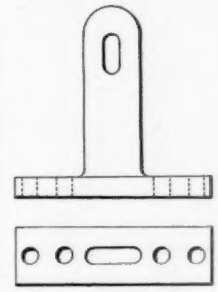


Fig. 5.

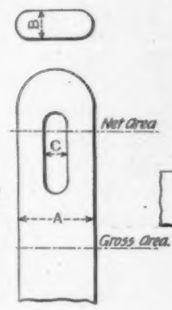


Fig. 6.

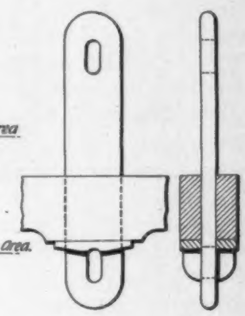


Fig. 7.

TABLE NO. 1.

Showing the net area and working stresses of spring hanger s and equalize posts. Net area in the table is taken through the slot. The working stresses are based on the net area. The gross area i the sectional area without any deduction for the slot. See Fig. 6:

Size of hanger.		Width of slot.	Gross area.	Net area through slot.	Working stress.		
A	B	C			3,500 lbs.	4 000 lbs.	4,500 lbs.
Inches	Inches.	Inches.					
2	⅝	⅝	1 16	.77	2,690	3,080	3,460
2¼	⅝	⅝	1.33	.93	3,250	3,720	4,180
2½	⅝	¾	1.47	1 00	3,500	4,000	4,500
2½	¾	¾	1 75	1 19	4,160	4,760	5,350
2¾	⅝	¾	1.66	1.19	4,160	4,760	5,350
2¾	¾	¾	1.94	1 38	4,830	5,520	6,210
2¾	⅞	¾	2.24	1.59	5,560	6,360	7,150
3	¾	¾	2.13	1 57	5,490	6,280	7,060
3	⅞	¾	2 46	1.80	6,300	7,200	8,100
3¼	¾	¾	2.32	1.75	6 120	7,000	7.870
3¼	⅞	¾	2 68	2.03	7,100	8,120	9,130
3¼	⅞	⅞	2 68	1.92	6,720	7.680	8,640
3½	¾	¾	2 50	1.94	6,790	7,760	8,730
3½	⅞	¾	2.90	2 25	7,870	9,000	10,120
3¾	⅞	¾	3.12	2.47	8,640	9.880	11,110
4	⅞	⅞	3 33	2.57	8 990	10,280	11 560
4	1	1	3.78	2.78	9,730	11,120	12,510
4½	1	1	4 28	3 28	11,480	13,120	14,760
5	1	1	4.78	3.78	13,230	15,120	17,010
5	1	1¼	4.78	3 53	12,350	14,120	15,880
5½	1	1	5 28	4.28	14,980	17 120	19 260
5½	1	1¼	5 28	4.03	14,100	16,120	18,130
6	1	1	5.78	4.78	16,730	19.120	21,510
6	1	1¼	5.78	4 53	15,850	18,120	20,380

The working loads given above are supposed to be the net weight resting upon the rails, less that of the wheels, axles, boxes and eccentrics.

$\frac{b\,d^2}{6}$ **TABLE 2.—MODULUS OF SECTIONS, SOLID RECTANGULAR BEAMS, AXIS HORIZONTAL.** For center load $\frac{W\,l}{4}$ or ¼ l W. For uniform load $\frac{W\,l}{8}$ or ⅛ l W

Depth.	Width. ⅛	¼	⅜	½	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
1	.02	.04	.06	.08	.10	.12	.14	.16	.18	.20	.22	.24	.26	.28	.30	.32
1¼	.03	.06	.10	.13	.16	.19	.23	.26	.29	.32	.36	.39	.42	.45	.49	.52
1½	.05	.09	.14	.18	.23	.28	.32	.37	.42	.46	.51	.55	.60	.65	.69	.74
1¾	.06	.13	.19	.25	.32	.38	.43	.51	.57	.64	.70	.76	.83	.89	.94	1.04
2	.08	.16	.25	.33	.41	.49	.58	.66	74	.82	.91	.99	1.07	1.15	1.24	1.32
2¼	.10	.21	.31	.42	.52	.63	.73	.84	.94	1.05	1.15	1.26	1.36	1.47	1.57	1.68
2½	.13	.26	.39	.52	.65	.78	.91	1.04	1.17	1.30	1.43	1.56	1.69	1.82	1.95	2.08
2¾	.16	.31	.47	.63	.79	.94	1.10	1.26	1.42	1.57	1.73	1.89	2.05	2.20	2.36	2.52
3	.19	.37	.56	.75	.94	1.12	1.21	1.50	1.69	1.87	2.06	2.25	2.44	2.62	2.71	3.00
3¼	.22	.44	.66	.88	1.10	1.32	1.54	1.76	1.98	2.20	2.41	2.64	2.86	3.08	3.30	3.52
3½	.25	.51	.76	1.02	1.27	1.53	1.78	2 04	2.29	2.55	2.80	3.06	3.31	3.57	3.82	4.08
3¾	.29	.58	.88	1.17	1.46	1.75	2.05	2.34	2.63	2.92	3.22	3.51	3.80	4.09	4.39	4.68
4	.33	.67	1.00	1.33	1.67	1.99	2.34	2.67	3.00	3.34	3.67	4.00	4 34	4.68	5.01	5.34
4¼	.38	.75	1.13	1.50	1.88	2.26	2.63	3.01	3.39	3.76	4.14	4.51	4.89	5.27	5.64	6.02
4½	.42	.84	1.27	1.69	2.11	2.53	2.96	3.38	3.80	4.22	4.65	5.07	5.49	5.91	6.34	6.76
4¾	.47	.94	1.41	1.88	2 35	2.82	3.29	3.76	4.23	4.70	5.17	5.64	6.11	6.58	7.05	7.52
5	.52	1.04	1.56	2.08	2.60	3.13	3.65	4.17	4 69	5.21	5.73	6.25	6.77	7.30	7.82	8.34
5¼	.57	1.14	1.72	2.29	2.87	3.44	4.01	4.59	5.17	5.73	6.31	6.88	7.46	8.03	8.60	9.19
5½	.63	1.26	1.89	2.52	3.15	3 78	4.41	5.04	5.67	6.30	6.93	7.56	8.19	8.82	9.45	10.08
5¾	.69	1.38	2.06	2.75	3.44	4.13	4.82	5.51	6.20	6.89	7.57	8.26	8.95	9.64	10.33	11 02
6	.75	1.50	2.25	3.00	3.75	4.50	5 25	6.00	6.75	7.50	8.25	9.00	9.75	10.50	11.25	12 00
6¼	.81	1.63	2.44	3 25	4.06	4.88	5.69	6.51	7.32	8 14	8.95	9.76	10.57	11.39	12.20	13.02
6½	.88	1.76	2.64	3.52	4.40	5.28	6.16	7.04	7.92	8.80	9.68	10.56	11 44	12.32	13.20	14.08
6¾	.95	1.90	2.84	3.79	4.74	5.69	6.64	7.59	8.54	9.48	10.43	11.38	12.33	13.28	14.23	15 18
7	1.02	2.04	3.06	4.08	5.10	6.12	7.14	8.16	9.18	10.20	11.22	12.24	13.26	14.28	15.30	16.32
7¼	1.09	2.19	3.28	4.38	5.47	6.57	7.66	8.76	9.85	10.95	12.04	13.14	14 23	15.33	16.42	17.52
7½	1.17	2.34	3 51	4.68	5.85	7.03	8.20	9.37	10 54	11.71	12.88	14.05	15 22	16.40	17.57	18.74
7¾	1.25	2.50	3.75	5.00	6.25	7.50	8.76	10.01	11.26	12.51	13.76	15.01	16.26	17.51	18.77	20 02
8	1 33	2 66	3.99	5.33	6.65	7.99	9.32	10.66	11.99	13.32	14.65	15.99	17.31	18.64	19.99	21.32
8¼	1.41	2.83	4.25	5.67	7.08	8 50	9.92	11.34	12.75	14.17	15.59	17 01	18.39	19.84	21.26	22.68
8½	1.50	3 01	4.51	6.02	7.52	9.03	10.53	12.04	13.54	15.05	16.54	18.06	19.56	21.07	22.57	24.08
8¾	1.59	3.19	4.78	6.38	7.97	9.57	11.16	12.76	14.35	15.95	17.54	19.14	20.73	22.33	23.92	25.52
9	1.68	3.37	5.06	6.75	8.40	10.12	11.81	13.50	15.18	16.87	18.56	20.25	21.90	23.62	25.31	27.00
9¼	1.78	3.56	5.34	7.13	8.91	10.69	12 48	14.26	16.04	17.82	19.60	21.39	23.17	24.95	26.74	28.52
9½	1.88	3.76	5.64	7.52	9.40	11.28	13.16	15.04	16.92	18.80	20.68	22.56	24.44	26.32	28.20	30.08
9¾	1.98	3.96	5.94	7.92	9.90	11.88	13.86	15.84	17.82	19.80	21.78	23.76	25.74	27.72	29.70	31.68
10	2.08	4.16	6.24	8.33	10.41	12.48	14.57	16 66	18.74	20.82	22.90	24.99	27.07	29.14	31.23	33.33

Formerly nearly all locomotives were built with the form of equalizer post or fulcrum, shown in Fig. 5. This answered very well for light engines, four 1-inch or 1⅛-inch bolts being sufficiently strong, so that little or no trouble was experienced with moderate loads. Owing to the comparative lightness, allowing the foot to bend or spring slightly, the two center bolts must evidently hold most of the weight. With heavy engines this form is the source of continual trouble from the bolts working loose and breaking. Slotting the frame and running the post through is a much better construction. See Fig. 7. Usually the frame is made deeper at the slot and protected from undue wear by a steel plate. The full strength of the material is utilized in this form with no chance of failure from imperfect welds, upsetting or other sources of possible impairment of strength.

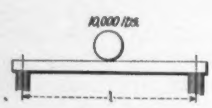


Fig. 8.

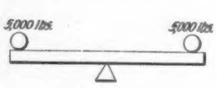


Fig. 9.

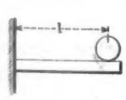


Fig. 10

Equalizer fulcrums should be proportioned for a working stress of 4,000 to 4,500 pounds per square inch. The equalizing beams connecting the springs together, when made of good hammered wrought iron or mild steel, should be calculated for 10,000 pounds to 12,000 maximum fiber stress. When made of first-class hammered iron they do not seem in practice to break in the center when the load equals 15,000 pounds per square inch, although the liability to bend or deflect too much might be an objection. It may be noted in this connection that the effects of impact should apparently be as noticeable in the beams as in the hangers uniting the springs to the beams, and require a correspondingly low working fiber stress. This, however, is not borne out by breakages of the parts in use, and the figures given (10,000 to 12,000 pounds per square inch) represent what is known to be good practice.

Nearly all equalizers are beams supported at the center and loaded with single uniform loads at either end, as in Fig. 9. This evidently is the same method of loading as the more familiar one, Fig. 8, of a beam supported at each end with a single center load, equal to both the loads in the first instance.

To determine the strength of beams of various sections to resist bending for different methods of loading:

Let l = length in inches.
h = depth in inches.
b = width in inches.
R = section modulus.
W = load in pounds.
S = maximum fiber stress per square inch.
M = bending moment in inch pounds = Wl or $\frac{\text{Wab}}{l}$.
I = moment of inertia of section.

$$R = \frac{b\,h^2}{6} \text{ solid rectangles.}$$

$$I = \frac{b\,h^3}{12} = R = \frac{I}{\frac{1}{2}h}.$$

(1) Fixed at one end—Single load Fig. 10. $S = \frac{M}{R}$.

(2) Supported at both ends—Single center load Fig. 8.

$$S = \frac{M}{4\,R}.$$

(3) Supported at both ends—Distributed load Fig. 11.

$$S = \frac{M}{8\,R}.$$

(4) Supported at both ends—Single load at any point Fig. 12.

$$S = \frac{W\,a\,b}{R}.$$

(5) Supported at both ends—Two equal loads at any point Fig. 13. $S = \frac{\frac{1}{2}\,Wa}{R}$.

(Half of sum of both loads.)

To determine the maximum stress S per square inch for the ordinary type of equalizer, Fig. 14, length, load, height and width being given, considered as a beam supported at both ends and loaded in the center:

$$S = \frac{W\,l}{4\,R}.$$

For a given stress, length, depth and breadth, to determine the load W:

$$W = \frac{RS4}{l}.$$

For a given stress, length, load and breadth to determine the depth h:

$$h = \sqrt{\frac{lW6}{bS4}}.$$

For a given stress, length and load to determine from Table No. 2 the modulus of section "R" required:

$$R = \frac{Wl}{S4}.$$

From Table No. 2 may be found the modulus of section "R"

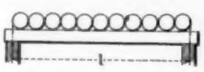


Fig. 11.

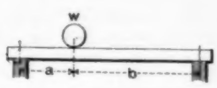


Fig. 12.

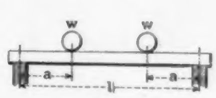


Fig. 13.

for any depth of beam from 1 to 10 inches, varying by ¼ inches and widths from ⅛ to 2 inches, varying by ⅛ inches. Maximum fiber stress per square inch $= \frac{M}{R}$. For different methods of supporting and loading, the value of "M" is given below:

(1) For a single concentrated load, beam fixed at one end, Fig. 10. $M = Wl$.

(2) For a single load concentrated at the center, beam supported at both ends, Fig. 8. $M = \frac{Wl}{4}$.

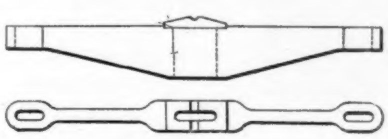


Fig. 14.

(3) For a distributed load, beam supported at both ends, Fig. 11. $M = \frac{Wl}{8}$.

(4) For a single load concentrated at any point, beam supported at both ends, Fig 12. $M = \frac{Wab}{l}$ which may be substituted for Wl in the preceding formulae.

(5) For two symetrical loads at two points, beam supported a both ends, Fig. 13. $M = \frac{1}{2} Wa$.

In addition to their being well designed and of sufficiently large sectional area to sustain the weight of the engine without exceeding the suggested fibre stress, the parts under discussion should be made of only the best quality of material. Wrought iron for this purpose should have a tensile strength of not less than 48,000 pounds per square inch, with an elongation of not less than 25 per cent. in eight inches. So comparatively small is the amount of material required to make the spring hangers for an engine that the additional cost of the best iron for this purpose is but trifling.

Application blanks for employment have been sent out to alumni of the Massachusetts Institute of Technology for the purpose of enabling the Secretary to facilitate communication between graduates available for employment and persons desiring to employ them. While not all will use them, the plan offers opportunities for those who desire to change their business connections to do so. The blanks provide for statements of experience. They are kept on file for one year and are used by the Secretary in answering applications for young men. Such a systematic way of carrying out the employment bureau function of technical schools is heartily commended, especially in view of the present extraordinary industrial activity.

PHOSPHOR BRONZE—A DESCRIPTION OF ITS CHARACTERISTICS AND METHODS OF MANUFACTURE.

By L. L. Smith.

Phosphor bronze is an alloy consisting primarily of copper and tin, to which phosphorus has been added as a deoxidizing agent. The action of phosphorus in this capacity will presently be considered at length. Phosphor bronzes for bearing purposes contain lead in addition to the copper, tin and phosphorus. Whether or not lead is introduced into the composition depends upon the character of service for which the alloy is intended.

The classification of phosphor bronzes of commerce may be made by dividing them into two general classes and designating them as high tensile bronzes and bearing bronzes. The former class is made up of alloys suitable for tubes, wire, springs, screws, etc., and for castings subjected to severe stress. For these purposes high tensile strength, toughness and resilience are required. The latter class includes alloys suitable for bearing parts of machinery, and may contain from 5 per cent. to 10 per cent. of lead. The lead, while greatly improving the bearing qualities, detracts materially from the tensile strength and toughness of the alloys. These latter qualities, however, are not of prime importance in the ordinary bearing and may readily be sacrificed in order to obtain a cool running, satisfactory bearing.

History of Manufacture.

The history of phosphor bronze manufacture extends back over several decades, for the use of phophorus in bronze is by no means a recent discovery. As early as 1858, it was observed that the addition of a small quantity of phosphorus to copper and tin during the melting exerted a very beneficial influence on the bronze, by increasing its toughness and tensile strength, and by producing greater homogeneity throughout the mass of the alloy. The use of phosphorus in copper-tin alloys was continued to a limited extent, but it was not until some ten years later that phosphor bronze was exploited on a commercial scale by Messrs. Montefiore and Kuenzel, of Liege. In the manufacture of bronzes of high tensile strength, phosphorus as a deoxidizing and improving agent, became such a recognized success that its use in a similar capacity for bearing bronzes soon followed.

The use of phosphor bronze for locomotive bearings has been so generally adopted that at the present time it may almost be regarded as the standard bearing alloy in American railway practice. The results of investigations by Dr. C. B. Dudley of bearing metals on the Pennsylvania Railroad have undoubtedly had much to do with the general adoption of phosphor bronze as a railway bearing alloy. Dr. Dudley's investigations, published in the Journal of the Franklin Institute, Feb. and Mar., 1892, demonstrated by comparative trials of various bearing alloys, the superior qualities of phosphor bronze.

Composition and Specifications.

The composition of Pennsylvania Railroad Standard Phosphor Bronze, as published by Dr. Dudley, and which, with slight variations, has been generally adopted by other railroads, is as follows:

Copper, 79.7.
Tin, 10.0.
Lead, 9.5.
Phosphorus, .8.

The practice of the Chicago, Burlington & Quincy Railroad is represented by the following recent specification:

"1. Phosphor bronze must have the following composition in borings taken from any ingot or casting in the lot:

Copper not less than 77% nor more than 81%.
Tin not less than 9% nor more than 11%.
Lead not less than 9% nor more than 11%.
Phosphorus not less than 0.7 nor more than 1%.

"2. Ingots must have a concave or shrunken surface on the upper or open side.

"3. Castings must be free from blow holes and porosity; their fracture must show an even appearance and must be entirely free from oxides and dirt.

"4. Material failing these requirements will be rejected."

Action of Phosphorus in Bronze.

In order to understand the action of phosphorus in the manufacture of bronzes, one must take into consideration the characteristics of their principal component, copper. Copper in its molten state exhibits a strong affinity for oxygen. If a

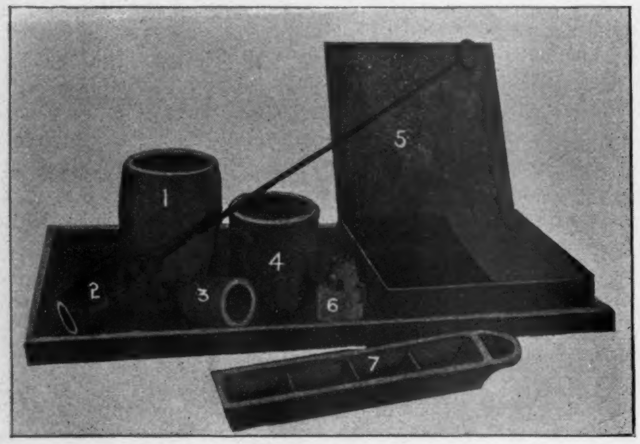


Fig. 1.

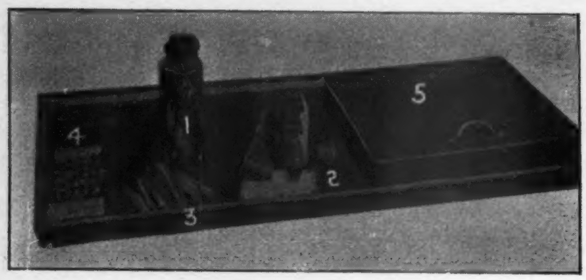


Fig. 2.

crucible of molten copper be exposed to the atmosphere without having over its surface a layer of charcoal, glass or other protective covering, the metal will absorb oxygen from the air. Also oxides of copper, if opportunity is afforded, are readily taken into solution by the molten copper. Oxygen, when present in an alloy of copper, is extremely prejudicial to satisfactory results when a uniformly strong, tough structural bronze or a homogeneous cool running bearing is desired. When the alloy having absorbed oxygen is cast, the copper oxide segregates near the upper surface of the ingot or the casting, in a discolored mass, which, on account of its black, greenish or reddish appearance, is visible in the fracture when the casting is broken. These spots will be a source of weakness if strength is desired, or will form hard spots of poor bearing qualities if a good bearing is wanted. In the ordinary course of events, in the manufacture of bronze it is almost impossible to prevent copper from absorbing some oxygen; therefore, in order to get rid of the oxygen, recourse is had to the use of some flux or deoxidizing agent. This flux, uniting with such oxygen as may be present, forms a constituent of a slag, which, separating out and rising to the top, leaves the alloy free from oxygen and renders possible the production of sound castings of homogeneous structure. Various fluxes for bronzes have been successfully used, among which are phosphorus, manganese, silicon, zinc and aluminum, each having its especial peculiarities, advantages and disadvantages. However interesting these may be, our consideration will be confined to the first mentioned of these; viz., phosphorus.

Phosphorus is a non-metallic substance, and is known to commerce in two forms, red phosphorus and yellow phosphorus. These two forms, while identical chemically, are widely different in physical appearance and behavior. Yellow stick phosphorus is the form chiefly employed for bronzes. Stick phosphorus is translucent, yellowish white in color, and of a waxy consistency; not unlike a tallow candle in weight and general appearance. The sticks are cylindrical, about 9-16 inch in diameter and 11 inches long. The material is received from the manufacturers in sealed tin cans, each containing about fifty sticks immersed in water. As above noted the function of the phosphorus in the bronze is that of a cleansing agent rather than as a vital element in its fundamental make-up. In fact a large excess of phosphorus over the amount needed to deoxidize the alloy is in most cases undesirable. The effect of excess phosphorus upon the physical qualities of bronze is to increase the hardness at the expense of toughness and malleability, furthermore it lowers the melting point. Excellent bronzes for certain purposes may contain only a trace of phosphorus. For parts requiring strength or toughness, chemical analysis should not show to exceed 0.2 or 0.3 per cent., and for bearing parts not to exceed 0.8 per cent. to 1 per cent. The fracture of a phosphor bronze casting intended for bearing purposes should present a close grained, uniform, mouse-colored appearance, free from segregation and discolored oxide spots.

Fig. 3.

Foundry Treatment of the Alloy.

To obtain proper results with phosphor bronze, care must be taken with its manipulation in the foundry. Even with the best materials in correct proportions, unless care and judgment are exercised in the foundry treatment, the product will be unsatisfactory, and perhaps even unfit for use. In this connection it may be remarked that the proper heat of pouring phosphor bronze is of the highest importance. Before pouring, the alloy should be cooled down almost to the temperature at which it begins to solidify. If poured too hot, a segregation of components will result. If such a hot poured casting be broken, the mottled appearance of the fracture will plainly show the segregation which has taken place. In fact, with bronzes in general the appearance of a freshly made fracture furnishes an excellent medium for judging the qualities and properties of the alloys.

Methods of Introducing Phosphorus.

The methods of introducing phosphorus into a bronze are quite numerous, but the following are three most commonly used: 1st. By adding stick phosphorus direct into the crucible of molten bronze. 2d. By adding to the other bronze constituents, phosphor-tin consisting of about 95 per cent. tin and 5 per cent. phosphorus. 3d. By adding phosphor-copper consisting of from 5 per cent. to 7 per cent. phosphorus, the balance being copper.

Our attention will be confined chiefly to the last mentioned method and to a detailed description of the preparation of the phosphor copper. Phosphor copper is frequently made containing 8 or 10 per cent. of tin, and in such cases the material is known to

the trade as "hardener" or "hardening." The reason that tin is made a constituent of hardener is, that in the case a bronze contains tin and copper, say, in the proportion of 1 to 8, the hardener also containing tin and copper in the same proportion may be added to the bronze in any desired quantity without disturbing the relative proportions of the constituent materials.

The Manufacture of Hardener.

Fig. 1 shows the appliances necessary for the manufacture of the hardener as follows: 1. An ordinary graphite crucible such as is used in melting of brass and bronze. 2. A cup-shaped graphite phosphorizer. 3. Same as 2, without the iron handle. It is here photographed to show more clearly its form. 4. A 3-gallon earthenware jar for holding copper sulphate solution. 5. A galvanized iron pan 6 inches deep. Suspended across the pan near the top is a heavy wire netting—the pan is provided with a hinged lid shown closed in Fig. 2. 6. A respirator consisting of a soft rubber case, containing a wet sponge—this respirator is worn over the mouth and nose of the workman to protect his respiratory organs from the disagreeable fumes of anhydrous phosphoric acid generated during the phosphorizing process. 7. An ingot mold into which the hardener is poured into cakes about 4 x 6 x ¾ inches. Fig. 2 shows the materials required. 1. A can of stick phosphorus. 2. Ingot copper. 3. Block tin cut into pieces of convenient size. 4. A box of copper sulphate.

In preparing the hardener, 142 pounds of copper are melted under charcoal in a crucible, and 17 pounds of tin are added. The phosphorus sticks are broken in two and placed in a weak solution of copper sulphate in the earthen jar. The phosphorus reduces copper from the solution and a coating of metallic copper is deposited on the surface of the stick phosphorus, preventing its too ready ignition when exposed to the air. The portion of the pan below the netting is partly filled with water for the purpose of keeping the contents cool. Over the netting is spread a sheet of blotting paper on which the copper coated sticks of phosphorus are allowed to dry. This being accomplished, the pot of metal is pulled out of the furnace, and one workman stands with the phosphorizer somewhat in the manner indicated in Fig. 3; a second workman with his hands protected by gloves grasps four sticks of phosphorus, and by a dexterous movement throws them into the cup-shaped phosphorizer, which is immediately plunged into molten metal. After a half minute or so the phosphorus is absorbed by the molten metal, then another charge is delivered, and so on until 11 pounds of phosphorus have been charged. The hardener is then poured out into cakes as before described. During the phosphorizing process dense fumes of phosphoric acid are given off, but the amount in weight of phosphorus so lost is comparatively trifling.

The hardener thus produced, according to analysis, contains 6 per cent. of phosphorus. This large percentage of phosphorus lowers the melting point of the material to such an extent that it solidifies only on cooling to a very dark red or almost black heat. A cake of hardener, when broken, presents a bright metallic fracture of a steel gray color, notwithstanding copper enters into its composition to the extent of 83 per cent.

Having the hardener at hand, the making of phosphor bronze consists merely of charging into a crucible in proper proportions copper, tin, hardener and lead (if required), melting and pouring at a proper heat.

A 100-horse power engine operated for about 60 cents per day for fuel expenses, appears to be an extravagant promise. This is the claim reecntly made for a gas engine, and producer gas where fine anthracite coal is used. If not at present possible, it is worth working for.

The University of Illinois has established a course in Railway Engineering, to be opened in September of the current year. The department will be under the charge of Prof. L. P. Breckenridge.

COMPOUND LOCOMOTIVES ON THE NORTHERN PACIFIC RAILWAY.

The records of compound and simple locomotives on the Northern Pacific, made the subject of a paper by Mr. E. M. Herr before the Western Railway Club, are believed to offer the most valuable information of this kind which has appeared. They apparently establish the compound upon a satisfactory basis, when the details of design and construction are properly carried out, and they support the opinion which has often been expressed in these columns, that when a compound is designed so that it will not break down on the road, and when it is made powerful enough to do the required work, it will be considered a satisfactory type, and it will be used on account of the saving in fuel.

Mr. Herr's paper should have the most careful attention of motive power and operating officers for four reasons, the first being the favorable showing made by compounds and the second being the admirable treatment of the important subject of distributing locomotives in accordance with their adaptability to meet the special and peculiar conditions of particular divisions. The third is the value of heavy and powerful engines, while the fourth is the wastefulness of delayed trains.

The use of compounds on this road has been extensive and intelligent. The new designs were made with unusual care, and the engines were not petted, but were put to hard work. That they were not "babied" is seen in the fact that one of the passenger engines ran more than 108,000 miles in twelve months, and this without coming into the shops for repairs. The systems of compounding represented were the Vauclain, the Richmond, the Pittsburgh and Schenectady. The sizes and types ranged from a mogul weighing 85,000 pounds on the drivers, and with 19 and 27 by 24-inch cylinders, to a mountain mastodon engine with 150,000 pounds on the drivers and with cylinders 23 and 34 by 30 inches. All of the records were kept in terms of 1,000-ton miles, the cost of repairs being stated also in engine miles.

No particular compound gave results that were universally better than the others, but it was found that one which was never worked with live steam in the low-pressure cylinder gave the highest average. This engine had the great disadvantage of stalling and found little favor with the operating department on this account. Herein is an important matter of design, because no engine can be a success if unsatisfactory in hauling capacity. A compound that is lacking in power when run as a compound and yet can not be converted, on occasion, into a simple engine, must be unpopular, although its coal record per mile run may be relatively high.

The freight compounds gave the best results on the division where they were fully loaded in both directions, averaging 28.4 per cent. over the simple engines of the same class carrying 180 pounds steam pressure and 35.7 per cent. over lighter simple engines having 150 pounds steam pressure. These compounds were capable of hauling heavy trains, and this is the secret of their remarkable success in this case. The passenger compound ran 273 miles continuously with trains weighing about 500 tons, and sometimes 550 tons, and in only two months out of 14 covered by the record, did the compound fail to show superior economy. In these cases it was found that the compound was handicapped by delayed trains and making up the time, combined with bad weather, accounted for the failure to show good results in those two months. During another month the conditions were reversed and the compound was favored to an equal extent The average gain in economy from compounding in passenger service was 14.6 per cent. This was unusually heavy service, however, which is favorable to this type, and on the other hand the later records were taken after the compound had made more than 100,000 miles and the simple 90,000 miles.

The repairs to the compounds seem to be no more, and they are certainly not less than those of the simples. This is a favorable showing, but it is probable that with longer service

the cost of repairs will increase rather faster for the compound than for the simple engine. In the case of these passenger engines the conditions were severe enough for a thorough test of the compound, because both engines were always double and often triple crewed, the mileage of the compound was greater than that of the simple, and yet the repairs were practically the same.

The great importance of using the compounds where they may work to the best advantage is seen in the record of the Vauclain compound in the heavy mountain service, for which the design was best adapted. This engine was a consolidation Baldwin, simple, converted into a compound with cylinders 15 and 25 by 28 inches, and weighing 138,000 pounds on drivers and having 180 pounds steam pressure. This engine, considering the lighter train hauled, gave better steam economy than the heavy mastodon compound of the two cylinder type with cylinders 23 and 34 by 30 inches, weighing 150,000 pounds on drivers and carrying 200 pounds steam pressure. The four-cylinder engine showed better economy than the two-cylinder type in the mountain service and not in the road service, because when worked at nearly full stroke the ratio of expansion in the two-cylinder is not sufficent to use the steam as economically as in the use of the four cylinder type. This fact has an important bearing on the expansion ratio of mountain pushing locomotives.

The Northern Pacific method of taking up the compound is commendable. It is such as to develop the question thoroughly and the results seem to be as follows: The compound is more economical than the simple engine. If well designed, it does not break down on the road and the running repairs need not be more expensive than those of simple engines. The compound features are not those which generally give the most trouble, but other parts which are common to both simple and compound engines and require to be designed with special care in the compound. The compound works most favorably a division where the work is nearly constant in both directions. Four-cylinder compounds work very favorably on heavy mountain grades where engines of whatever type are worked "full stroke." The speed of trains has a very important effect upon the economy of the compound.

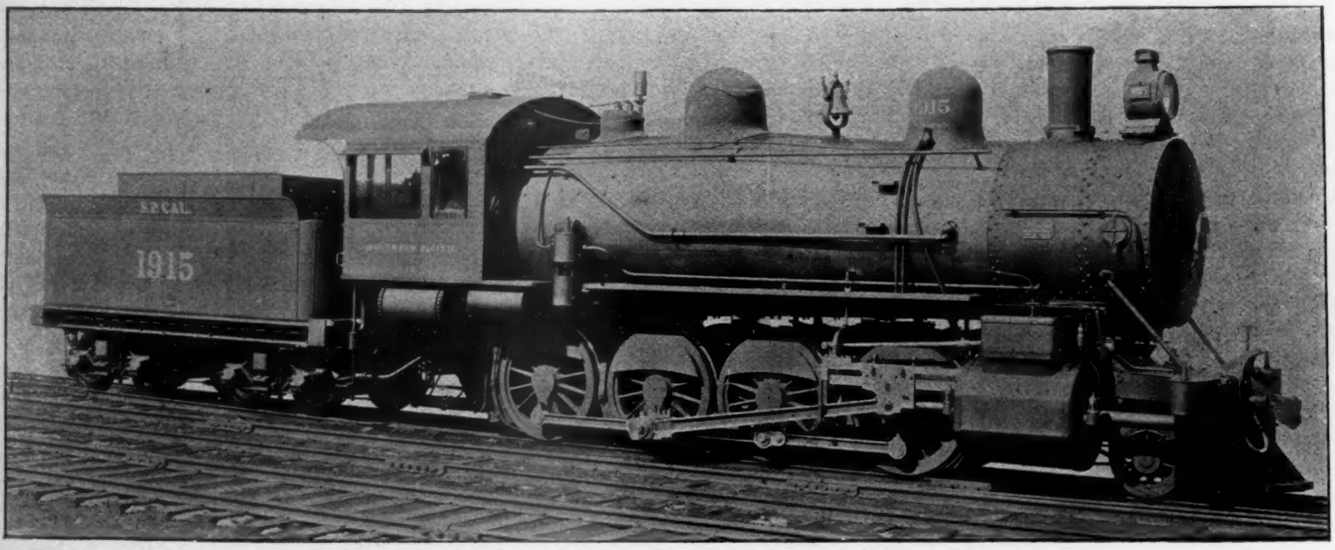
It is believed that this excellent paper will exert a very important influence on the future of the compound locomotive. The opinions are expressed with calmness and intelligence and without prejudice. The period of observation was sufficiently long and the service was very exacting. The only question remaining is what the records will be after five or ten years of service.

CONSOLIDATION AND MOGUL LOCOMOTIVES.

SOUTHERN PACIFIC COMPANY.

Compound Consolidation.

The Schenectady Locomotive Works have just delivered six very heavy compound locomotives of the two-cylinder type to the Southern Pacific Company for freight service on the heavy grades of that road in California. These are the most powerful two-cylinder compounds of which we have record. The cylinders are 23 and 35 inches in diameter and 34 inches stroke. These may be compared with the mastodon Schenectady compounds of the Northern Pacific, with cylinders 23 and 34 by 30 inches, with the Baldwin two-cylinder compounds for the Norfolk & Western, with cylinders 23 and 35 by 32 inches, with the Schenectady mastodon compounds for the Southern Pacific, with cylinders 23 and 35 by 32 inches, and also with the Northern Pacific Class Y consolidation engines, with cylinders 23 and 34 by 34 inches. These heavy engines are all working under 200 pounds steam pressure, except the design we are now describing, which is using 220 pounds. The boiler sheets are unusually thick, as will be seen by the table of dimensions. This high pressure and the large heating surface, 3,027 square feet, with the larger cylinder capacity, form a remarkably powerful combination, and we are informed that the engines are giving excellent results, both in fuel economy and in power developed.



Compound Consolidation Locomotive—Southern Pacific Railway.

SCHENECTADY LOCOMOTIVE WORKS, *Builders.* H. J. SMALL, *Superintendent of Motive Power.*

The weight on driving wheels is 173,000 pounds, which is, we believe, the greatest weight used in what are generally termed "road engines." The power of this engine may be profitably compared with the mastodon type shown on page 26 of our January, 1899, issue. The more advantageous arrangement of carrying the weight in the consolidation design is at once apparent. We shall not give space now to a discussion of these interesting subjects, but we desire to note the rapid advances that are being made in the power of freight locomotives. The chief dimensions are as follows:

General Dimensions.

Gauge	4 feet 8½ inches
Fuel	Bituminous coal
Weight in working order	193,000 pounds
" on drivers	173,000 pounds
Wheel base, driving	15 feet 8 inches
" " rigid	15 feet 8 inches
" " total	24 feet 4 inches

Cylinders.

Diameter of cylinders	23 and 35 inches
Stroke of piston	34 inches
Horizontal thickness of piston	5¾ and 4¾ inches
Diameter of piston rod	3¾ inches
Kind " " packing	Cast iron

Size of steam ports .H. P., 20 inches x 1⅝ inches; L. P., 23 x 2⅛ inches
" " exhaust " ..H. P., 20 inches x 3 inches; L. P., 23 x 3 inches
" " bridges ....1⅜ inches

Valves.

Kind of slide valves ....Allen-American
Greatest travel of slide valves ....6 inches
Outside lap " " " ....H. P., 1⅛ inches; L. P., 1 inch
Inside " " " " ....¼ inch
Lead of valves in full gear ....1/16 inch

Wheels, Etc.

Diameter of driving wheels outside of tire ....57 inches
Material " " " centers ....Cast steel
Driving box material ....Cast steel
Diameter and length of driving journals......9 inches dia. x 12 inches
" " " " main crank pin journals,
6½ inches dia. x 6 inches
Diameter and length of side rod crank pin journals,
F. and B. 5 x 3¾ inches Inter. 5½ inches dia. x 4¾ inches
Engine truck journals....................6 inches dia. x 10 inches
Diameter of engine truck wheels ....30 inches
Kind " " " " ....Krupp No. 3 steel tire

Boiler.

Style ....Extended wagon top
Outside diameter of first ring ....72 inches
Working pressure ....220 pounds

Simple Mogul Locomotives.

The second engraving illustrates one of a lot of 12 simple, mogul engines furnished by the same builders, of which the following table gives the chief characteristics:

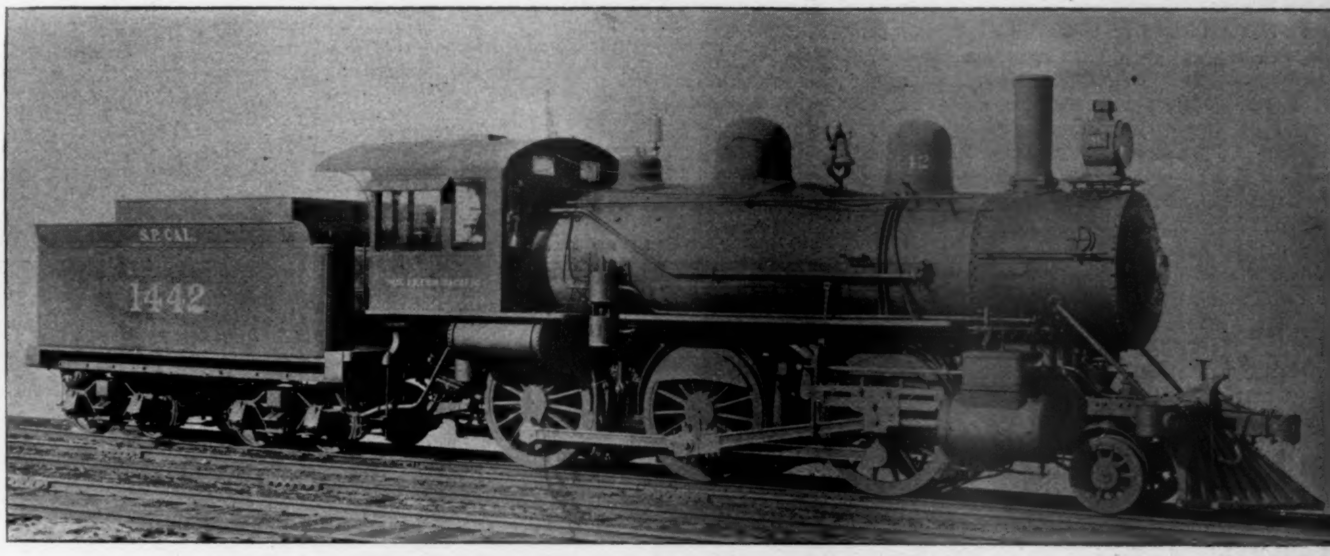
Gauge ....4 feet 8½ inches
Fuel ....Bituminous coal
Weight in working order ....142,600 pounds
" on drivers ....123,700 pounds
Wheel base, driving ....15 feet 2 inches
" " rigid ....15 feet 2 inches
" " total ....23 feet 3 inches
" " " of engine and tender ....46 feet 8½ inches

Cylinders.

Diameter of cylinders ....20 inches
Stroke of piston ....28 inches
Horizontal thickness of piston ....5¼ inches
Diameter of piston rod ....3½ inches
Kind of piston packing ....Cast iron rings
Size of steam ports ....18 inches x 1¾ inches
" " exhaust " ....18 inches x 3 inches
" " bridges ....1⅜ inches

Valyes.

Kind of slide valves ....Allen-American



Simple Mogul Locomotive—Souther Pacific Railway.

SCHENECTADY LOCOMOTIVE WORKS, *Builders.* H. J. SMALL, *Superintendent of Motive Power.*

Material of barrel and outside of fire-box ....Carbon steel
Thickness of plates in barrel and outside of fire-box,
13/16, ¾, 9/16, ⅞ inches
Fire-box, length ....126 inches
" " width ....40⅜ inches
" " depth ....F. 77 B. 73½ inches
" " material ....Carbon steel
" " plates, thickness, sides, 5/16 inch; back, 5/16 inch;
crown, ⅜ inch; tube sheet, 9/16 inch
Fire-box, water space, front, 4½ inches; sides, 3½ inches to
4 inches; back, 3½ inches to 4½ inches
Fire-box, crown staying ....Radial 1⅛ inches diameter
" " stay bolts ....1 inch diameter
Tubes, material ....Charcoal iron No. 12
" number of 332
" diameter ....2¼ inches
" length over tube sheets ....14 feet 6 inches
Fire brick, supported on ....Studs
Heating surface, tubes ....2817.30 square feet
" " fire-box ....210.50 square feet
" " total ....3027.80 square feet
Grate " ....35.3 square feet
" Style ....Rocking
Ash pan " ....Hopper, worked by air dampers front and back
Exhaust pipes ....Single
" nozzles ....5¼ inches, 5½ inches and 5¾ inches dia.
Smoke stack, inside diameter..18 inches at top, 16 inches near bottom
" " top above rail ....14 feet 11½ inches
Boiler supplied by two injectors ....Monitor No. 10

Tender.

Weight, empty ....38,200 pounds
Wheels, number of 8
" diameter ....33 inches
Journals, diameter and length ....4½ inches dia. x 8 inches
Wheel base ....15 feet ¼ inches
Tender frame ....10 inches steel channels
" trucks, 2-4 whl. channel iron cen. bearing F. & B. side
bearings on back truck
Water capacity ....4,000 United States gallons
Coal " ....9 tons
Total wheel base of engine and tender ....51 feet ¾ inch

These engines have the Westinghouse air brake and also the Sweeney brake arrangement on the left cylinder and Le Chatelier water brake on the low pressure cylinder.

Greatest travel of slide valves ....6 inches
Outside lap " " " ....1 inch
Inside " " " " ....1/32 inch
Lead of valves in full gear ....Line and line

Wheels, Etc.

Diameter of driving wheels outside of tire ....63 inches
Material " " " centers ....Cast steel
Tire held by ....Shrinkage
Driving box material ....Cast steel
Diameter and length of driving journals....9 inches dia. x 12 inches
" " " " main crank pin journals,
6 inches dia. x 6 inches
" " " " side rod crank pin journals, main
side 5¼ inches x 6½ inches, 5 inches dia. x 3¾ inches
Engine truck, kind ....2 wheel swing bolster
" " journals ....6 inches dia. x 10 inches
Diameter of engine truck wheels ....30 inches
Kind " " " " ....Krupp steel tired

Boiler.

Style ....Extended wagon top
Outside diameter of first ring ....62 inches
Working pressure ....190 pounds
Material of barrel and outside of firebox ....Carbon steel
Thickness of plates in barrel and outside of firebox,
9/16, ½, ⅝, 11/16 inches
Firebox, length ....108⅛ inches
" width ....40¼ inches
" depth ....F., 73 inches; B., 59½ inches
" material ....Carbon steel
" plates, thickness,
sides, ⅜ inches; back, ⅜ inches; crown, ⅜ inches; tube sheet, ½ inch.
Firebox, water space..front, 4 inches; sides,
3½ inches; back, 3½ inches
" crown staying ....Radial, 1 inch diameter
" stay bolts ....⅞ inches and 1 inch diameter
Tubes, material ....Charcoal iron, No. 12 B. W. G.
" number of 312
" diameter ....2 inches
" length over tube sheets ....12 feet
Fire brick, supported on ....Studs
Heating surface, tubes ....1946.7 square feet..
" " firebox ....168.0 square feet
" " total ....2,114.7 square feet
Grate " ....30.22 square feet

Grate, style	Rocking, with drop plates
Ash pan, "	Hopper operated by air with dampers front and back
Exhaust pipes	Single
" nozzles	4¾-5 inches to 5¼ inches diameter
Smokestack, inside diameter, 16 inches at top, 14 inches near bottom	
" top above rail	14 feet 11¼ inches
Boiler supplied by two injectors, Monitor No. 9.	

Tender.

Weight, empty	39,650 pounds
Wheels, number of	8
" diameter	33 inches
Journals " and length	5 inches diameter x 9 inches
Wheel base	15 feet
Tender frame	10-inch channel iron
" trucks, 4-wheel channel iron, cen. bearing F. & B. side bearings on back truck	
Water capacity	4,500 U. S. gallons
Coal "	10 tons

COMMUNICATIONS.

LEHIGH VALLEY FREIGHT LOCOMOTIVES.

Editor "American Engineer":

I notice an article commencing on page 110 in your April issue on the new consolidation freight locomotives for the Lehigh Valley RR., and it appears to me that there is a misapprehension regarding the arrangement of spring gear on the lighter engine of the two illustrated on page 111. As I read the drawing, the spring arrangement is not continuously equalized, but the back end of the intermediate spring is secured to the frame with a spring hanger and the leading end of the spring between the drivers and intermediate wheels is also secured to the frame below the rocker box. I shall be pleased to have this cleared up. I am also desirous of learning how the nickel steel piston rods are made hollow between the piston and crosshead fits without the end being open.

Canadian Pacific Ry.
Montreal, April 5, 1899. R. ATKINSON,
Mechanical Superintendent.

[Mr. Atkinson directs our attention to an error in the description of the Lehigh Valley locomotives, which is explained by the letter from Mr. F. F. Gaines, Mechanical Engineer of the road, which is printed below.

As to the method of making the hollow piston rods, we are informed by the Baldwin Locomotive Works, the builders of the engines, that they were first forged solid, the hole then bored out and the ends closed.—Editor.]

Editor "American Engineer":

The equalizing system of our new engines is not continuous, although from its method of connection to the frame it might possibly be so construed. We use an extra spring over the general practice on consolidation engines, and in order to tie the end of this spring at the brake and equalizer, and also clear the motion work, it was necessary to carry up our hangers from the top and bottom spring, and secure them by bolts to the frame direct. The line of hangers being a continuous vertical line, gives the impression that the equalization is continuous; it is not, however. F. F. GAINES,
Lehigh Valley RR. Mechanical Engineer.
South Easton, Pa., April 10, 1899.

THE GILMAN BRAKE POWER REGULATOR.

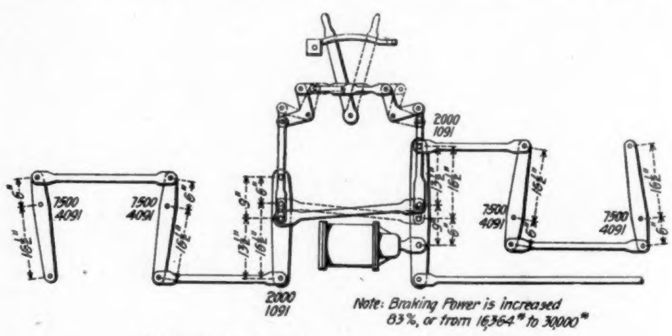
Editor "American Engineer":

I have been much interested in articles appearing in the columns of the "American Engineer" recently upon the subject of an improvement in the brake mechanism for freight cars of high carrying capacity to the end that a more uniform ratio of brake power might be maintained between empty and loaded cars. I fully agree with those who have said that an improvement in this direction has become a necessity. Not only is the fact apparent theoretically, but it is daily demonstrated on lines where a very considerable proportion of modern high capacity cars are being handled. This is especially true on lines operating over heavy grades.

Referring to Mr. Waitt's communication on page 80 of the March issue, after treating the subject at some length, he says that there are objections to the installation of too many automatic devices and appliances and he gives logical reasons in support of this position and then calls attention to the fact that it has been found practical to hold trainmen responsible for the proper manipulation of retaining valves with which most modern freight cars are now equipped. I fully agree with him and think that there should be no question as to the practicability of depending on trainmen for the proper handling of any such simple device with which railway companies may see fit to equip their cars. However, it would not be in harmony with common customs to introduce any new device or innovation on any railway line without exciting more or less criticism from the rank and file. Yet the men are not slow to discover the merits of any beneficient change and may soon defend the things they once viewed with distrust and suspicion.

Experience has established the custom of braking freight cars at 70 per cent. of their light weight. This is as high as is found prudent on account of the fact that when this limit is exceeded the number of slid flat wheels multiplies, and even when braking at 70 per cent. of light weight, the matter of slid flat wheels and the expense incident thereto is an item of vast importance.

Considering that the range of variation between the light and loaded weights of freight cars was constantly increasing, the fact was fully apparent that our cars were fast outgrowing their brakes. This induced me and my associates to study the subject with the result that there is in operation on the Pacific division of the Northern Pacific Ry. a train equipped with a brake power regulating device by which the car is



The Gilman Brake Power Regulator.

braking at but 60 per cent. when empty and 30 per cent. when loaded, instead of at 70 and 18 per cent., as originally. This proportion may be varied to suit the requirement of the service. I send you a sketch showing the plan of operation. We increase the brake power developed by changing the lever fulcrums three inches. I inclose also a copy of a report of a service test made with the first car equipped some six months ago. This car was braking at 70 per cent. when empty and at 30 per cent. when loaded, since which time we have reduced the ratio when empty and it would still further insure against slid flat wheels to reduce to 50 or 55 per cent. when empty, which is practical with our device. We can apply this principle of brake power regulator on twin hoppers as well as box or flat cars. You will note that we do not displace any of the standard brake rigging, but simply slot the body levers and add a few other pieces. The brake is giving excellent satisfaction in service. W. B. NORTON.
Tacoma, Wash., April 5, 1899.

[This device is known as the Gilman Brake Power Regulating device, Mr. G. H. Gilman, General Foreman of the Car Department of the Northern Pacific at Tacoma, having been one of its originators. The service tests mentioned by Mr. Norton show a material improvement in the distance required for stopping, which was to be expected, from the nature of the device. Mr. Wm. Forsyth, Superintendent of Motive Power of the road, writes that the device is now in use on 20 logging cars in special service.—Editor.]

CYLINDER CAPACITIES OF HEAVY LOCOMOTIVES.

Editor "American Engineer":

I would like to ask a few questions about some things said in your paper for April on the subjects of the Lehigh Valley pusher locomotives and the new road engines; also in regard to the cylinder capacities of plant heavy locomotives. Do you think 3-16-in. lateral motion on each side, or ⅜-in. total motion, good practice? We always took an engine in for repairs when the side play reached that point. They will soon enough get 3-16-in. if allowed 1-16-in. at start, and I don't think the Lehigh Valley RR. has any curves that will necessitate any such side

play, with the distances between tires they also give; furthermore, they will ride very badly.

Do you think an engine with 62 inch drivers and 30 inch stroke will have less piston speed than one with 50 inch drivers and 24 inch stroke? I do not think so; neither do I think it good practice to use an engine of this class in passenger service.

Do you think an engine ever reaches 25 or 30 per cent. of weight on drivers for available adhesion? I have never seen one get more than 20 to 22 per cent. with best dry rail or with sand. Do you think by increasing the cylinder capacity (as you say concerning the Pittsburgh engine, 23 to 23¾ inches diameter) there is less liability to slip? I do not, at least with the same pressure, weight and size of wheel. There would be more liability to slip, and I don't think the palm of power should be given the Lehigh Valley engines, as in fact they are more "over cylindered" than the Pittsburgh engine.

The fact of the matter is that the engines of to-day are not or do not show such a vast difference from those of years ago, as the ratio between tractive power and available adhesion is not so different. With the increase of weight also came the increase of boiler pressure and diameter of cylinders (and in some instances a decrease in diameter of drivers) in good proportion to the increase of weight on drivers.

Watertown, N. Y., April 4, 1899. F. W. NAGLE.

[Our correspondent seems to be laboring under some misapprehensions concerning the heavy locomotives illustrated in our April issue. Referring to the matter of lateral motion, we do not care to criticise the practice, as there are no doubt good reasons for the amount given. There are too many apparent advantages in the all-flanged tires to be wholly offset by the liberal lateral motion. As to these engines riding very badly, it has not developed that such is the case.

Replying to the question of piston speed, the example furnished by Mr. Nagle does not cover the case contemplated in our article, for the reason that we had in mind consolidation engines of 28 inch stroke, while he works on the hypothesis that such engines have 24 inch stroke, which, as a matter of fact, does not hold on the heavy locomotives of that type, and his figures work out very nicely to show that there is no difference in piston speeds. There is, however, quite a difference when a stroke of 28 inches is considered with a 50 inch wheel, a combination that has been running for several years. With the 50 inch wheels and 28 inch stroke, the piston speed at 30 miles per hour is 940 feet per minute, while with the 62 inch wheels and 30 inch stroke, the piston speed is 814 feet per minute; conclusions are easily drawn from the figures, but there is a matter of centrifugal force that enters here, and it is one so easily affected by wheel diameter that it assumes great importance.

The centrifugal force for the larger wheel at 30 miles an hour equals $\frac{W\ V^2}{g\ \ r} = 11.3$ pounds for each pound at a crank radius of 15 inches, and a like force for the 50 inch wheel is 16.3 lbs. for each pound at the center of gravity of a 14 inch crank. This shows the connection between the large and small wheel for fast heavy freight service, but a ride on an engine with the 50 inch wheel at the speed noted is a more conclusive test, and never fails to convince the doubter that the larger wheel is preferable when conservation of permanent way and machinery is an object of importance.

As to the use of the consolidation engine in passenger service, objection is raised, presumably on account of the two wheel truck, which is thought by some to be an element of danger. We do not advocate the use of consolidation engines for hauling passenger trains (our statement on this point is clear), but if the truck is the objectionable feature, the point is not well taken for the reason that mogul engines have been, and are now, used satisfactorily in regular passenger service.

With reference to the increase of cylinders from 23 to 23¾ inches diameter, we certainly do not think that the tendency of the engine to slip will be any less. It is well understood that the tractive power exerted at the rail should not be less than the adhesion, even if the latter is obtained by extraneous aids, since it is perfectly plain that of two engines similar in all respects, that which is the most powerful is the one that has the greater earning capacity when loaded to the limit.

Adhesion is now increased by the use of perfected sanding devices that place sand on the rail in quantities to suit requirements, enabling an engine to hold the rail under conditions that would be impossible without them. As intimated above, the tractive power is raised to a higher proportion of the adhesion in the later design of engines than ever before. Machines built on these lines must not be confounded with the over-cylindered engines of the past, with their very small boilers and inadequate heating surface. There is nothing in common between them. Those of the article in question, having a power closely approaching the adhesion, are well able to exert their maximum effort over long distances by reason of ample boiler capacity and heating surface, whereas the old engines that had a power rating on cylinder size alone soon became inert for want of steam capacity.

The proportion of adhesion to adhesive weight must necessarily depend on the condition of the rail and wheel, when these are considered alone, but experiments are not required now to demonstrate what that ratio is when the rail is fairly dry and sand is used. As a matter of fact, an adhesion equal to 25 per cent. of the adhesive weight is obtained under average conditions, and it is not uncommon to reach 30 per cent. with sand on a good rail. That is the reason why the ratio of tractive power to adhesion is increasing.—Editor.]

LIGHT AND HEAVY CARS.

Editor "American Engineer":

In your April, 1899, issue, you printed an article, "Light and Heavy Cars," that has greatly interested me.

Before going into the merits of the subject, the opinions of two highly successful railroad men must be considered. Mr. F. D. Adams, whom I have had occasion, during the last ten years, to consult frequently upon this very subject, says, "Light cars cannot be made to ride as well as heavier cars," and I regret exceedingly to say that Mr. Adams is greatly mistaken. The weight carried is not a factor in the riding of any moving vehicle, and so eminent an authority as Von Borries, Director General of the Prussian State Railroads, hopelessly errs in a paper he recently published on equalization and riding of locomotives, when he stated that the weight carried was the prime factor in the riding.

When you mention the riding of cars and locomotives you enter upon a unexplored field that the average railroad man has not the faintest conception of, and the leading railroad man is afraid to discuss because he does not know. The man who makes the springs is doing it under contract at a given price per pound, entirely regardless of the ability of the springs to absorb upward and downward thrusts.

Mr. E. E. Pratt, who is also a personal friend and with whom I have discussed this subject, also very frankly declares that he "does not think that a car must necessarily be heavy in order to ride smoothly." The operating expenses would show marked decrease if more of the men in charge of rolling stock would give careful study to dead weight, and also to devices that will cause this same rolling stock to ride with freedom from jolts and jars, and not act as sledge hammers to pound the permanent way to pieces.

In 1892, Mr. L. M. Butler, Superintendent of Motive Power of the New York, Providence & Boston RR., equipped six four-wheel buggy vans that were 16 feet over the sills and weighed 11,000 lbs., with our combination half leaf and spiral suspension. The marvelous change from the jiggle motion with the old springs to a velvet smoothness with the leaf and spiral was a revelation to Mr. Butler and the trainmen using the vans. These six vans are still in service, and ride as free from teetering as the heaviest sleeper; further, it is impossible when riding in one of these vans to count the rail joints, frogs and switches, no matter what the speed.

This combination of leaf and spiral is in service on the palatial private trains of the President of France, His Imperial Majesty the Czar of Russia, the Oriental express sleepers and dining cars, the electric cars of Paris and Chalons-sur-Mer, France, Alexandria, Egypt, and hundreds of electric cars in the United States, and the Canadian Pacific Railway are placing it under their locomotives with gratifying results.

The Metropolitan Street Ry. of New York are operating a number of combination open and closed cars 28 feet over the end sills, with two trucks, having eight wheels, driven by two motors and weighing 14 tons and seating 45 passengers. Our car is 24 feet over the end sills, has four wheels, one motor, weighs 3½ tons and seats 40 passengers, and the floor of this car is only 26 inches from the ground. It rides free from jars and jolts, either loaded or empty, and the motorman can stop it easier and quicker with a full load than when empty, without fear of sliding his wheels, although the leverage is 12 to 1.

J. HECTOR GRAHAM.

Boston, April 16, 1899.

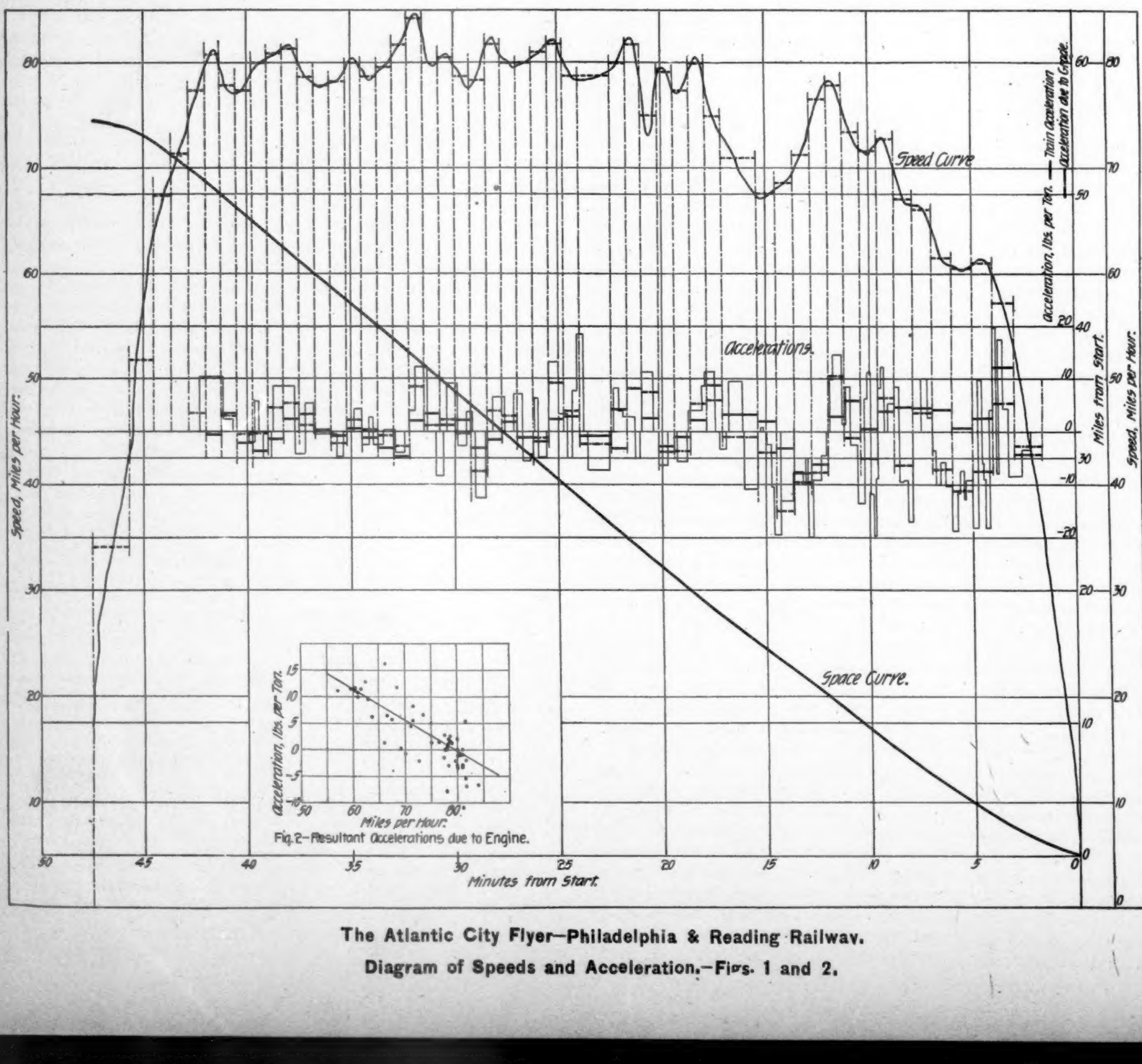
THE ATLANTIC CITY FLYER—PHILADELPHIA & READING RAILWAY.

Speed Accleration and Power.

By H. H. Vaughan.

In view of the discussion recently developed by the experiments on the model of the Baldwin compound locomotive at Purdue University and the correspondence between those experiments and the practical working of such engines demonstrated by Mr. Vauclain, an analysis of the performance of one of the engines of the Atlantic type on the fifty-minute run from Camden to Atlantic City may be of interest, although not of any definite scientific value. When Mr. G. M. Basford, editor of the "American Engineer," last summer timed this train so successfully (see issue of October, 1898, page 341), the added times by each mile corresponding with the total time of the run within a second, the writer made the attempt, based on such an accurate record, to deduce some relation between the power of the locomotive and the speed of the train that should eliminate the effect of the grades. The method used is illustrated in the accompanying diagrams, Figs. 1 and 2.

In Fig. 1 the abscissae are minutes, and the ordinates are for the space, velocity and acceleration curves, miles, miles per hour and pounds per ton respectively. The space curve is obtained by plotting points, corresponding to the record, and the curve through such points represents the distance of the train from the starting point at each minute of time. If this curve were to a sufficiently large scale its tangents would give the speed, but this method is inconvenient and not sufficiently accurate. The curve is however, useful, as by it the distance of the train from the starting point at any time, or, conversely, the time at which any point is passed, can be graphically obtained. A series of ordinates are therefore drawn, as shown in the upper part of the diagram, each of which corresponds to the time at which a mile post was passed. The horizontal lines between these ordinates represent the average speed for the mile which was passed in the time enclosd between them. Now, since this diagram is plotted with respect to time, the area enclosed between any two ordinates and the speed curve must equal the area enclosed between such ordinates and the horizontal line representing the mean speed for that time. This is shown in an approximate way by the curve which is roughly sketched in, which should show equal areas above and below the horizontal line. There is, however, no requirement as to regularity in the speed curve, apart from this question of areas, the only conditions are that it must be continuous and must not become vertical. A slight consideration will show that while the speed must change gradually, the rate of change of speed (shown by the slope of the speed line) may and probably does change practically instantaneously, or at any rate in a train length. For instance, suppose a train to be running at 70 miles per hour on the level, the engine exerting sufficient power to maintain that speed on arriving at a descending grade, within a train length acceleration will have taken place,



The Atlantic City Flyer—Philadelphia & Reading Railway.

Diagram of Speeds and Acceleration.—Figs. 1 and 2.

so that it is probable that the speed curve is in reality a series of curves and straight lines meeting at various angles. In fact, if both resistance and engine power are lineal functions of the speed, such must be the case.

On this acount it appears impossible to definitely determine the speed line, and in consequence the acceleration or retardation in each mile. The only way is to obtain an approximation and for this purpose the speed on passing each mile post was taken as the mean of the speed in the preceeding and succeeding miles.

The acceleration thus assumed can be measured from the mean speeds in miles per hour, and by constructing a suitable scale it can be plotted as feet per second or as the force necessary to cause such acceleration in pounds per ton of train. This force is shown by the heavy horizontal lines above and below the base line in the center of the diagram, the measurements above the base line being accelerations and those below retardations. The effect of the grades is plotted to the same base line and scale by obtaining the time at which each change of grade occurred from the distance of that point from the start, and the time at which the train passed it as shown by the space curve. Each grade will exert an accelerating or retarding force on the train, dependent upon its rate, and these forces are shown by the distance of the light horizontal lines from the base line, the light vertical lines marking the time at which each change of grade occurs. The height of a rectangle enclosing an area between the base line and two adjacent mile lines that is equal to the algebraic sum of the rectangles formed by the lines representing the grade accelerations and the base line between the same mile lines then represents the mean accelerating force due to grade during the time in which each mile was travelled, and this is shown by the horizontal dotted lines. The difference between this and the actual acceleration, either positive or negative, is evidently that due to the engine.

These results are plotted in Fig. 2, in which the abscissae are speeds in miles per hour, the dots representing the engine accelerations in pounds per ton. There are evidently great variations, partly no doubt due to the method employed, but on the whole the line drawn is not a bad representation of the result and it is clearly apparent that the engine is capable of maintaining a speed with this train of nearly 80 miles per hour on the level, or 60 miles per hour on a grade of five-tenths per cent., a very fine performance.

It is to a certain extent unfortunate that on the day the train was timed the engine was not worked up to its capacity, as the run has been made in considerably less time, and the fact that 48 minutes had to be consumed in making the trip is no doubt to a certain extent the cause of the variation in power shown at the same speed, although the impossibility of obtaining the exact accelerations is responsible for the greater part of it.

The petty and foolish opposition that early railroad builders were made to encounter seems ridiculous nowadays, and one of the strangest efforts in that line perhaps was that made against the construction of the first road in Germany, between Furth and Nuremberg, in 1836, when the Bavarian Medical College came out in a pronunciamento as follows: "Conveyance by means of a carriage propelled by steam ought to be prohibited in the interest of the public health, for the rapid motion cannot fail to create a disease of the brain among the passengers, which may be classed as a species of delirium furiosum. Even if travellers are prepared to run the risk, the onlookers ought by all means to be protected. The mere sight of a passing train suffices to create the same central disorder. This has been found out by experience and by actual observation. Wherefore, the authorities should insist on having a palisading of boards or of some similar material, at least 5 feet high, placed on each side of the permanent way."

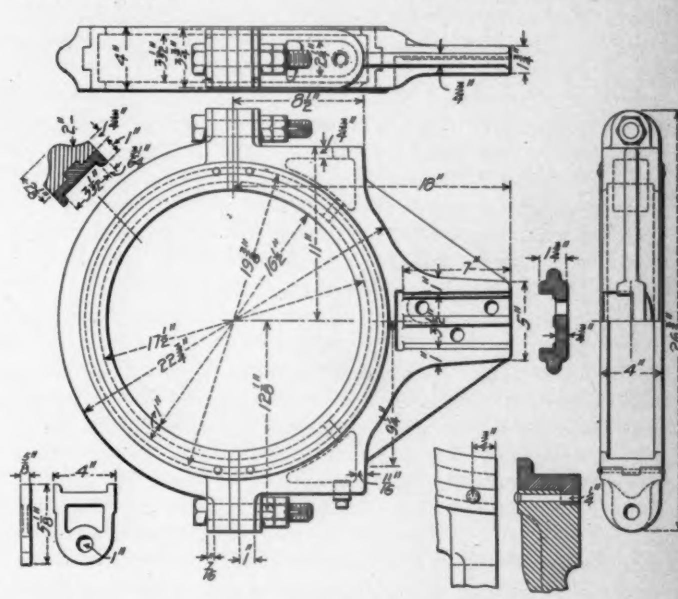
Great difficulty is reported by railroad men in getting rooms for the convention at Old Point Comfort.

BRASS LINED ECCENTRIC STRAP.

Chicago & Northwestern and Chicago, St. Paul, Minneapolis & Omaha Railways.

Many different methods have been tried in order to prevent trouble with heated eccentrics. The eccentric straps have been bored out and the bearing surface lined with babbitt metal, and, in some cases, the entire straps have been made of brass. In the accompanying engraving a brass lined eccentric strap is shown. It has all of the advantages of the all brass strap as to the quality of the bearing surface and is less expensive. With the brass liner carefully secured against revolving, this plan appears to be as good in every way as the more expensive one.

The drawing shows the form of the eccentric strap as made in cast steel. The liner is cast in a single piece and is cut to allow space for two ⅝-inch filing pieces, which are placed between the lugs. These serve to hold the liner from turning



Brass-Lined Eccentric Strap.

and also provide for taking up wear of the liner. The section of the liner and strap show the flange or rib on the outside of the liner, through which pins are passed near the lugs for the purpose of holding the liner in place when the strap is removed from the engine.

The experience of the Chicago & Northwestern shows that this arrangement reduces friction and the breaking and heating of eccentric straps is prevented. It is used on all new passenger locomotives for the Chicago and Northwestern. The credit for the design belongs to Mr. J. J. Ellis, Superintendent of Motive Power of the Chicago, St. Paul & Minneapolis & Omaha.

Mr. Ellis informs us that the first set of these straps were applied to a 19 by 24-inch ten-wheel locomotive running in fast passenger service and that they ran three years before they needed to be closed. The amount taken out at that time being but 1-16-inch. The straps are of cast steel and the liners of Ajax metal. Mr. Ellis says: "Most of our passenger engines are equipped with these cast steel eccentric straps and Ajax metal liners and are giving excellent service."

Electric motor carriages have received a severe blow in London through the removal of the electric cabs from service. According to published accounts, this was due to the expense of maintaining the storage batteries that were used there. The trouble arose from excessive expense of maintenance and a misunderstanding of the terms of the guarantee which resulted in this expense falling upon the cab company.

BURNISHED FINISH FOR JOURNALS AND PLAIN SURFACES.

While the use of rollers for producing burnished surfaces of journals and piston rods is now generally considered a great improvement upon other finish, it has met opposition from individuals, one of whom said only last year that he preferred to finish such surfaces with files and emery, because of the alleged poor condition of the surface given by the rollers. It may be said that where the roller has failed, the blame should not be placed on the method, but on its application.

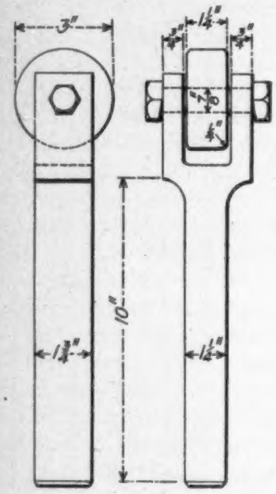


Fig. 1.

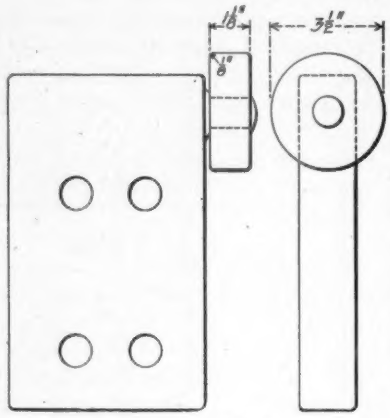


Fig. 2.

The rolled finish offers two advantages: First, in producing a smooth surface, and, second, in making the surface denser, and therefore harder. In producing these results all minute seams are closed and the surface is placed in a "broken in" condition at the start, which accounts for the remarkable absence of trouble from hot boxes when journals are finished in this way. It is necessary that the roller should have a working face free from scratches or grooves, or, in other words, it must be made as smooth as possible, and it must also be hardened before the final polish. Such a tool will produce a surface fully equal to that of cold rolled shafting, which on account of being smooth, dense and true, was thought a few years ago to be well adapted for piston rods, and was tried for that purpose; but it was found to be a poor substitute for the good iron then in use, for the reason that after the rolled surface had been worn through and a turning was necessary, the seamy surface exposed showed the cold rolled iron to be unfit for such use after the first wear, but it demonstrated that a cold rolled surface was satisfactory for piston rods.

No way has yet been devised by which steel can be finished sufficiently smooth direct from the tool to make an ideal bearing surface, and the barbaric file and emery are called into requisition to supply what the tool has failed to furnish. The tool leaves the work comparatively true, but not smooth enough, and the file reverses the conditions by leaving it smooth enough and compartively untrue. The province of the roller is to retain the truth of the turned surface and at the same time put it in the best possible condition to resist abrasion; this it does with varying degrees of excellence, according to the condition of the tool and the way it is used. In any event, the work when well done is better and cheaper than by any other process, a fact that is attested by our best machinery department managers, although there is some difference of opinion in the matter of width of roller-face and amount of curvative of the edge, as will be seen by the examples we illustrate. They all, however, produce a mirror-like surface.

Fig. 1 shows the practice of the New York, New Haven & Hartford. The corners of the wheel are seen to be rounded off to a radius of ¼-inch, corresponding to the fillets on the journal. This tool had a record of several thousand axles when we saw it and was still in first-class condition. A bush will be noticed in the roller, the purpose of which is to permit of taking up lost motion due to the thrust of the roller against the journal.

The Chesapeake & Ohio people use the roller on all axles, crank pins and piston rods. The roller for driving axle journals is shown in Fig. 2, the holder being a flat piece which is held by the tool bolts, and is reversible to adapt it for use in either direction, owing to the peculiarity of the service required of it. The roller for the other work named is quite similar to Fig. 1. This road gives the roller a very extended use, and file finishing is not permitted.

The practice of the Canadian Pacific, as shown in Fig. 3, furnishes an idea in original constructive detail in the bearing of the hardened steel roller in the tool steel shank. The roller is journaled and rests in the forked bearings. The pressure of the roller against the work holds it in place, and the incline of the bearings prevents displacement of the roller when not in use. Mr. R. Atkinson, Mechanical Superintendent of the Canadian Pacific, writes of his roller, as follows:

"I send you herewith a sketch of the roller which we use on journals and piston rods. You will notice that the roller has a flat face about ⅝-inch wide, which is amply sufficient to prevent corrugation or cording of the surface if it is carefully set, and I think it is better than to have the roller wider or larger in diameter, as has been suggested, and I understand is being used in some places. A roller of double the width requires twice the pressure against the lathe centers to produce the same surface effect and is therefore liable to spring the work or throw it out of the lathe. One-quarter-inch feed is easily covered and is ample to do fast work. It takes 45 minutes to burnish the largest piston rod we have with an extension tail rod for compound engines, namely, 6 feet 11⅝ inches long over all, 3 11-16 inches diameter of rod, and 2½ inches diameter for the extension tail rod.

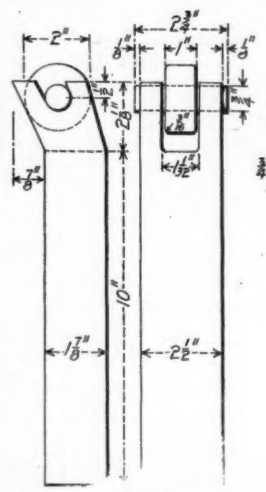


Fig. 3.

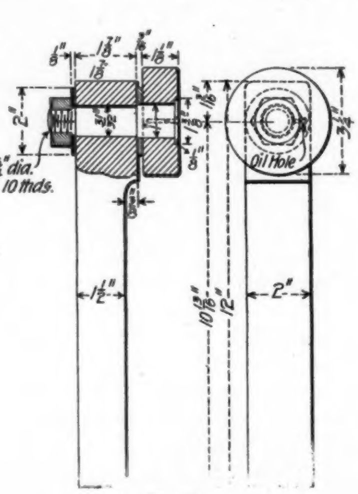


Fig. 4.

A similar piston rod without a tail rod can be burnished in thirty minutes, main crank pins in fifteen minutes, leading or trailing crank pins in seven or eight minutes, and I am sure no exception can be taken to the finish produced, as I have not yet seen any better anywhere. The speed for piston rods is about 120 feet per minute, and for crank pins and axle journals 90 feet."

The roller shown in Fig. 4 has some novel and original points, giving evidence of adaptability of the tool to a wider range of work than any one roller so far devised. The roller it will be seen is placed at one side of the shank or holder and can therefore be used with equal facility on straight work wthout shoulders, and driving axles or engine truck axles where the roller must be moved up to the wheel hub; this it is enabled to do, because it is reversible and may be turned to work to a shoulder in either direction. Its construction is well explained by the illustration. Mr. J. H. McConnell, Superin-

tendent of Motive Power of the Union Pacific, through whose courtesy we show this roller, writes of it as follows:

"We make use of this tool for the following purposes: Burnishing piston rods, valve stems, crank pins, driving axles, engine truck and tender axles and passenger and freight car axles. In addition, we use it to burnish the wedge face of steel

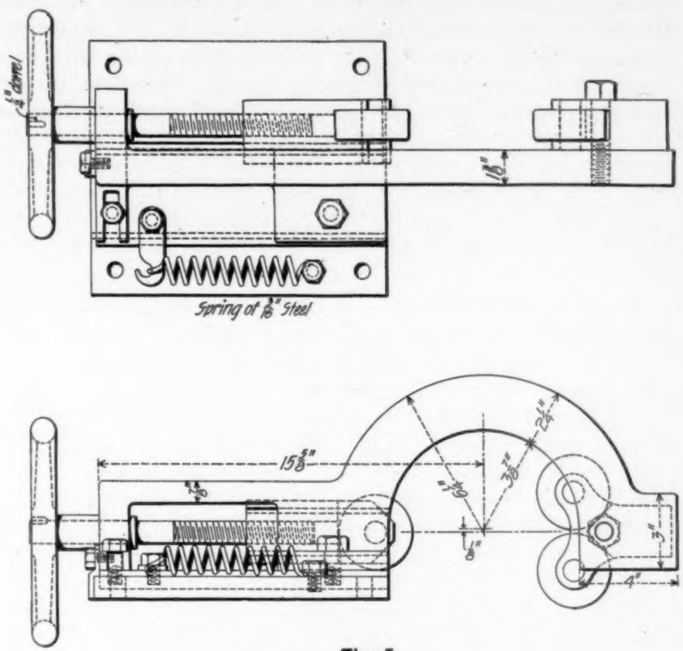


Fig. 5.

and cast iron driving boxes, also the driving box wedges and shoes. It is of great advantage to run this tool over the wedge faces of the cast steel driving boxes and shoes, as it condenses the surface of the metal and gives a smooth surface equal to that obtained by long wear in service. We find by this method that steel driving boxes run without cutting. An examination of a set after one year of service showed a surface like glass without a scratch. I believe it reduces the number of hot driving, tender and passenger car boxes. After the practice is once adopted, I do not believe any one would be willing to abandon it. The cost is less than by the old way of using a file and emery, as a coarser feed may be used when taking the water cut, because the roller does the rest."

Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway, says:

"We consider that the liability of journals to run hot is materially reduced by the use of this device. We have, since the rollers were last repaired and hardened, rolled 4,200 axles and there are no signs of the rollers needing repairs at present."

The tool referred to by Mr. Barr is shown in Fig. 5. It is more elaborately gotten up than any of the others and is designed on entirely different lines. The side elevation shows three rollers three inches in diameter by 1¼ surface, journaled in a frame which is secured to the lathe bed permanently, as seen by the bolt holes in the plan. The frame is curved so as to pass over and clear the work operated on, and it has two supporting wheels in the rear while the single wheel at the front is adjustable to the work by means of the hand wheel and screw as shown. The device is certainly a novel one, in that it furnishes support for the work operated on, and effectually prevents spring from the strain of the adjustable roller and it relieves the lathe centers from additional stress.

An arrangement devised by Mr. W. H. Owens, Master Mechanic of the Southern Railway, is shown in Fig. 6. This employs two rollers as a support for the piece, while the tool rest also carries a third roller, the device being arranged in this way with special reference to burnishing piston rods and valve stems which are so light as to bend under the pressure of a single roller. For rods of larger diameter, and for axles and crank pins a single roller, three inches in diameter, with a face two inches wide, is used.

The statement made by Mr. Atkinson relative to the increased pressure required with the wide faced roller is a timely one and in strict accord with the facts for single rollers. It should have the effect of reducing the width of the roller to the narrowest possible dimension consistent with smooth work. This, of course, will depend entirely on the rate of feed used. The hint is a valuable one, inasmuch as it will relieve the lathe and work of unnecessary stresses when the roller is properly designed. Mr. McConnell has shown the increased possibilities for the roller in his adaptation of it to the burnishing of plane surfaces. This is a unique and decidedly original use of the tool, and one as productive of good results as in any work it may be devoted to, not excepting that for which it was first designed. Its action is exactly similar wherever used, that is, making the surface denser and smoother; and there is no place on a locomotive where that condition is more desirable than on the faces of wedges and shoes and the corresponding surfaces on driving boxes. It appears to be specially adaptable to cast steel surfaces.

The rollers devised by Mr. Barr and Mr. Owens have been designed to overcome the springing of work referred to by Mr. Atkinson and are admirably adapted to that end, for work of a diameter likely to be distorted by pressure of the burnishing wheel. In this presentation of the evolution of the roller it is seen that there is more to it than is commonly believed, and also that its field of usefulness is being extended in a direction little expected by the man who first thought of it only as an improvement over the file for finishing journals. Our best information as to the origin of the roller for axle work (and this is believed to be its first use on the lathe in a railroad shop), gives credit to Mr. L. Barrett, Master Mechanic of the Missouri Pacific at St. Louis, Mo., as the inventor of the device, who conceived the idea of burnishing a journal, and followed up the idea to a successful conclusion. This occurred in 1891 or 1892.

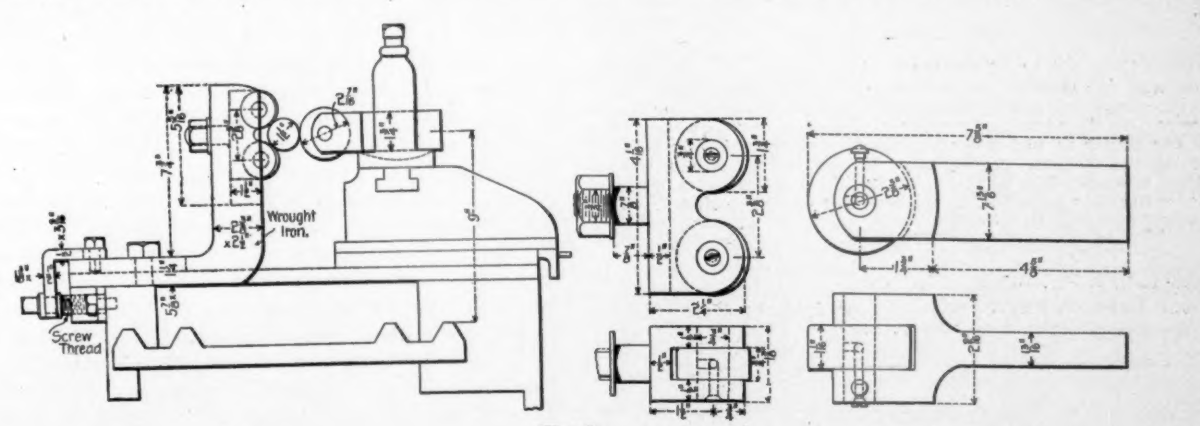


Fig. 6.

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CONTENTS.

The best iron, without regard to the price, is recommended by Mr. Francis Cole elsewhere in this issue, for making locomotive spring hangers and equalizers. His reason is made plain when he shows that iron having a tensile strength of about 48,000 pounds per square inch and an elongation of 25 per cent. in 8 inches, can not be safely used in these positions with fiber stresses greater than about 3,500 or 4,500 pounds per square inch for spring hangers, about 4,000 or 4,500 pounds for equalizer fulcrums and from 10,000 to 12,000 pounds for equalizers. These are very low limits, but they have been determined by experience, and they furnish a strong argument for the use of the best iron that money can buy. There is very little of this iron needed about a locomotive and the additional cost will hardly be noticed, whereas the return in the cost of repairs and the ability of the engines to keep the road may be expected to be very great.

Freedom among manufacturers in imparting information with regard to methods of manufacturing has had much to do with the remarkable progress of the United States during recent years. The technical associations have accelerated progress in this way and free criticism concerning methods has brought many improvements. Progress depends so much upon this free information idea that it may be said that the secret process plan is confined to small establishments and it is very seldom heard of in connection with the stable articles of manufacture. It is those lines in which the doors are wide open in which the world startling developments have been made. The man who leads is always ahead and is spurred on by being in the lead while he who follows without originating is always behind. In the open door plan, traditions have no place and improvement is the rule. Those who are unwilling to share their information are usually unwilling to learn and are followers being even behind those who follow intelligently. We have in mind business organizations having bright men at the heads of departments, who are not only discouraged from appearing in technical societies but are positively instructed not to take part in their discussions because nothing is to be gained by "giving away" information in this way. Is this a business-like way of looking at this important matter?

The size of driving axle journals of locomotives, as seen in a number of recent designs, seems to be one of the details that is considered comparatively unimportant, because of the variety of practice that is found. Our attention is directed to this matter by the practice of one of the locomotive building firms, which is illustrated by two locomotives of very different types and weights, both of the designs being shown by engravings in this issue. One of these locomotives is of the consolidation type, weighing 173,000 pounds on the driving wheels, and the other is a mogul weighing but 123,700 pounds on its drivers. These two designs have exactly the same sized driving journals, namely 9 by 12 inches. As we understand it, this means that these builders believe in using the largest journals that they are able to provide for in the structure of the engines, for these are but two examples of practice that they have followed for some time. It may be said that the load carried by a driving axle does not vary very much in powerful engines of whatever type, because of the desire to load the wheels as heavily as track conditions permit. In the cases cited the load on each journal of the mogul is only 1,000 pounds less than that on each journal of the very heavy consolidation engine, but as the lighter engine will probably run in very much faster service than the other, the maximum fibre stresses may not be very different. It appears to be a good plan, especially as the fiber stresses are not to be measured, that the journals should be made as large as structural conditions will permit. Surface velocity will be troublesome after a certain diameter is reached, and the weight will prevent the dimensions from going to extremes, probably the direction that future axle design will take will be in the use of stronger material.

Valve gears are usually designed with considerable care and they are intended to distribute steam to the cylinders favorably, especially when the valves are balanced, but it is well known that the intended distribution is not always attained. Interesting examples of the variable amount of work obtained from the same engine without altering the cut-off speed or steam pressure described by Prof. Smart in an article to appear next month. This may be considered as an additional argument in favor of piston valves. Prof. Smart also directs attention to the bad effect of even slightly increasing the clearance in locomotive cylinders. This must be kept in mind when designing piston valves. We know of simple locomotives in which a change from flat to piston valves has brought about an improvement in economy equal to that generally expected from compounding. This leads to the conclusion that compounds with piston valves ought to be very economical and this view is supported by service records.

AMOUNT AND DISTRIBUTION OF WORK IN BUILDING A LOCOMOTIVE.

Planning and estimating the requirements and cost of new shops is a difficult problem that occasionally confronts motive power men. Except notes that individuals have collected in the course of their experience, there are no data from which to estimate the number of tools of each kind that will be required to build or repair a given number of locomotives per year, and yet this is the first information that is required. We have been repeatedly asked for information of this kind and we appreciate the need for a complete analysis of the detail work on a locomotive. It would be valuable as a starting point in many important matters of shop management in which knowledge of costs is required and accurate knowledge of costs is the foundation of businesslike management.

Details taken in building locomotives are available from the painstaking and laborious investigations of Mr. T. R. Browne, who has analyzed the construction of a modern consolidation locomotive, and the results were printed in his article in our January (1899) issue, page 23, under the caption, "General Summary of Tools and Their Arrangement." The information contained in this article is an excellent beginning for the general analysis that ought to be made, and we desire to direct attention to it again, because such figures have never before been published.

Calculations were made to embrace the important operations on a locomotive of the consolidation type, the purpose being to avoid minor details, such as tank work, foundry work, and wood work, a consideration of which would surround the subject with unnecessary complications. The results are stated concisely in the following table under the general divisions and subdivisions:

TOTAL AMOUNT OF WORK IN MACHINE SHOP.

Planing Square inches.	Turning. Square inches.	Boring. Square inches.	Milling. Square inches.	Slotting. Square inches.	Cold-sawing. Square inches.	Drilling. Linear inches.	Tapping. Linear inches.
77,089	83,419	9,916	13,995	20,116	595	6,852	612

TOTAL AMOUNT OF WORK IN BOLT DEPARTMENT.

Blacksmith shop:—

Turning. Linear inches.	Threading bolts and studs. Linear inches.	Threading nuts. Linear inches.
3,363¼	11,421½	2,833½

TOTAL AMOUNT OF FORGING IN BLACKSMITH SHOP.

Total amount of forging in blacksmith shop, including forgings of bolt department.................................... 61,819 lbs.

TOTAL AMOUNT OF WORK IN BOILER SHOP.

Planing edges of plates. Square inches.	Shearing. Square inches.	Punching. Holes.	Tapping. Linear inches.
2,253	2,653	10,915	733

The operations in the several shops are given in terms of square and lineal inches of cutting, which is a novel and rational way to put the results, since they afford a means of arriving at the cost of such work at once. Brass work is not included in the table, for the reason that the amount of such work for one engine bears a small ratio to the iron work, and the means now used in finishing brass are of such an improved character that it was believed to be unnecessary. It is shown that 46.3 per cent. of all planing is done on frames, cylinders, footplates, guide yokes, truck plates, frame braces, steam chests, bumper castings and pedestal braces. In all turning operations 64.2 per cent. is covered by wheel centers, tires, axles, lift shafts, rockers, cylinder heads, pistons and rings, boiler rings, front ends and extension rings, steam chests, eccentrics and straps. Of slotting, 70 per cent. is required on frames and braces, crossheads, foot plates, bumper castings, guide yokes and driving boxes. Of the milling, 87 per cent. is required by guide yokes, crossheads, rods and braces, mud rings, guides, main axles, links, link hangers and guide yoke knees; 89 per cent. of the boring is done on cylinders, crossheads, rocker boxes, lift shaft bearings, lift shafts and rockers; 68.7 per cent. of the drilling is required on rods, crossheads, holes for pedestal bolts and cylinders. Of the work of tapping holes, 6 per cent. is called for on cylinders, pistons and other large details, and these are tapped in the machine where they are drilled.

The gaps in these figures are filled by smaller parts by a system of grouping at special tools. Seventy per cent. of bolt and stud turning in the bolt department of the blacksmith department shop comprises bolts and studs from 5/16 to 1 inch, and the remainder from 1 inch and above. Of the thread work, 74 per cent. includes bolts and studs from 5/16 to 1 inch, and the balance from 1 inch up. In the tapping of nuts, 39 per cent. are comprised in nuts from 5/16 to 1 inch, and the remainder from 1 inch up.

A continuation of the information in percentages shows the total of forging to come within the following range: 58.9 per cent. takes in frames, braces, guide yokes, rods, truck plates, pistons, and that variety of heavy work done on hammers of from 6,000 to 8,000 pounds capacity; 20 per cent. is in mud rings, front end extension rings, spring rigging, link and valve motion, crossheads, link shafts, rockers, and also those forgings reaching the capacity of a 3,000-pound hammer. Bolts and work done in the bolt department absorb 6 per cent., and all of the smaller classes of forgings for which it is not desirable to make by special tools and which are usually done on the anvil, constitute the balance of the smithshop work.

Although the steam hammer is referred to as a prominent adjunct in a larger part of the blacksmith shop work, equal prominence is given to production of forgings by means of dies, the analysis being specially valuable in directing attention to possibilities for reducing the machine work and performing the work in such ways as will permit of saving the time of the machines. One of the advantages of die work in forging is to be found in the small amount of stock necessary to be left for removal in finishing, in many cases grinding sufficing for the purpose, which is one of the results of dies properly made and used. Another argument in favor of the dies is the fact that intricate shapes can be more expeditiously turned out by them than is possible by any other method of forging. The dies are used with pressure and not impact, for it is well understood that a blow will not cause a flow of metal and will not reach the interior of metal so readily and satisfactorily as pressure. A forging machine will reduce the cost of blacksmithing, and will also materially reduce the time consumed in removing stock in the machine shop, a saving of labor in both operations. The steam hammer, owing to extravagant consumption of steam, it is thought, may be replaced by the forging machine at a less cost for steam to get the pressure for the hydraulic machine, for equal capacity of tools.

An important result of this examination was to show that about one-half of the time of the shop tools is taken up in the fixing of work and in the recovery of the tools for the next cut. About one-third of the time of reciprocating tools while running is taken up in the recovery of the tool for the next operation. One-half of the time of a steam hammer is spent with the hammer head in the air, and the same may be said of ordinary punches. About one-half of a man's time is spent

in waiting for the machine to do its work, and if the time of both men and machines could be economized, the costs might be reduced considerably. There is an oportunity to make great improvements in this direction by the use of fixtures in the machines whereby the work may be dropped in place and fastened without the necessity for special care in placing it. By the use of such devices an ordinary man may be used to take the place of the expert mechanic required by the usual methods, and the work may be, at least, as well done. This, by the way, is a strong argument for the adoption of uniform sizes of parts.

That portion of the article under discussion which refers to the "personal equation" of the individual operator and its application to the percentages given is one of greatest importance in its bearing on the results, for the reason that the wage question and ability of the worker will enter as factors to vitiate or sustain the figures given in the tables indicating the amount of work required for one engine. The recommendations and suggestions made are of the greatest importance to the progressive head of the railroad shop, and we cannot do better than to recommend all who are interested in cheapening the cost of shop production to familiarize themselves with the whole of the article. It cannot but be of interest in any case, and will be found invaluable in many.

A strong argument in favor of cleaning locomotives at frequent intervals, offered in a recent discussion, was that of safety. By the examination incident to the wiping of engines a great many defects and incipient break downs are discovered before they become serious enough to cause failures on the road, and many that are discovered in this way would escape an inspector.

The stereopticon is used very successfully by Mr. W. J. Murphy, Superintendent of the Cincinnati Southern, in the instruction and examination of employees of that road. It has many advantages over other methods, because, by the use of slides, the candidate may, in effect, be taken to any part of the road and brought into contact with the conditions as if he were actually on the ground. This is particularly valuable in the case of questions in regard to signaling, and the plan will appeal to those who have tried to explain the use of signals by diagrams , or, in fact, by any method other than by the signals themselves. Mr. Murphy, however, is able to place various examples of signaling before the men in a way that is both quicker and better than the use of the objects themselves. The plan is a good one that should bring out a great many imitators.

The deepest sounding on record, says the "Army and Navy Journal," has been obtained by the officers of the surveying ship Penguin (Captain Field), which recently returned to Sydney from her work in the vicinity of the Tonga Islands. Between Tonga and Auckland a sounding was obtained at the depth of 4,762 fathoms, the patent sounding machine supplied to all ships of war being used for the purpose. The temperature at this depth was 35.5 degrees, as compared with 82 degrees at the surface of the water. A depth of 4,655 fathoms had been found previously off the coast of Japan by Commander Blake, U. S. N.; 4,561 fathoms off Porto Rico, by Lieut. Comdr. Brownson, U. S. N. This depth of 4,655 has been questioned because the wire broke and no specimens were brought up, but there was a record on deck the moment the wire ceased running out. The previous day the wire broke at 4,411 fathoms. Specimens were obtained two days before at depths of 4,360 and 4,356 fathoms. These soundings were made by the U. S. S. Tuscarora in June, 1873, between Yokohama, Japan, and Tanaga Islands, Aleutian Group. There was also a sounding of 4,643 fathoms when the wire broke before reaching bottom.

A CHAPTER IN LOCOMOTIVE STACKS.

Union Pacific Ry.

It is well known that the Union Pacific practice in the matter of front end arrangements includes the diamond stack. This form is not now in general use on other roads, but it was decided upon by Mr. J. H. McConnell, Superintendent of Motive Power, as being the best arrangement for securing free-steaming qualities and preventing the serious losses from fires which were set in large numbers by the peculiar action of lignite fuel in combination with open stacks: Mr. McConnell is always ready to defend his present practice with the strong argument that good results are given by it, particularly in regard to free steaming and elimination of spark throwing.

He has had the kindness to prepare for us a series of drawings showing the variety of designs of stacks covering the experience of that road from 1864 to the present time, and, contrary to the opinion of many, the road has certainly given a great deal of attention to the straight stack, as this record shows, and before deciding upon the present standard a number of designs of straight stacks were used.

The Congdon smoke-box plan, patented by Mr. J. H. Congdon

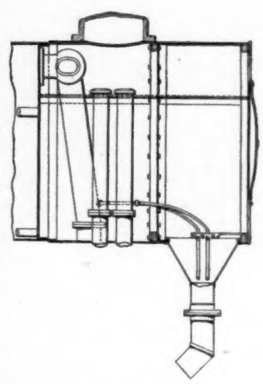


Fig. 1.

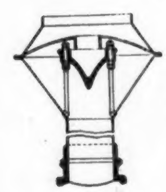


Fig. 2.

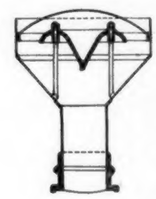


Fig. 3.

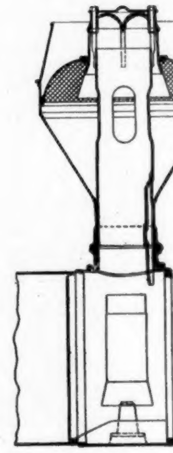


Fig. 4.

in 1864, and applied by him when Superintendent of Motive Power of this road, in 1867, is shown in Fig. 1. This arrangement had a horizontal netting near the top of the high nozzles which were double, and one in front of the other. No dimensions are given in this drawing, but it is evident that the extension front was a long one. This was used on a number of engines for several years, when it gave place, in 1870, to the Jarett diamond stack, Fig. 2. This was followed by the Fountain stack, also of the diamond pattern, in 1875, Fig. 3. In 1878 another form of the Congdon stack, Fig. 4, was used, and a return was made in 1885 to the straight stack shown in Fig. 5.

In 1885 eight different arrangements of this straight stack were tried, the general plan being as shown in Figs. 5 and 6, the difference being in the location of the deflection plates, of which some used one and others two and even three. In 1888 the "Barnes" extension front end, Fig. 7, was employed. The plate A shows the fender as first arranged, and B shows its position afterward. An arrangement of additional nettings, as in Fig. 8, was applied in 1889, and later in the same year a modification of the "Barnes" plan was used, as indicated in Fig. 9. Figs. 10 and 11 were used simultaneously, and in 1890, which we believe was the date of Mr. McConnell's appointment, a return to the diamond stack, as in Figs. 12 and 13, was made. It will be noticed that the form shown in Fig. 13 has a short extension. The straight stack, Fig. 14, was used to some ex-

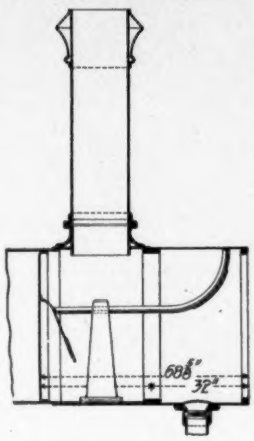


Fig. 5.

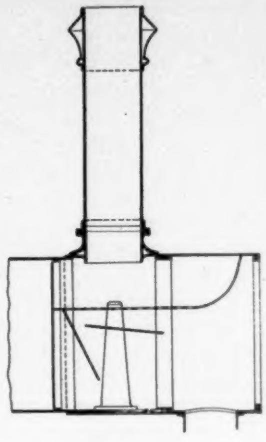


Fig. 6.

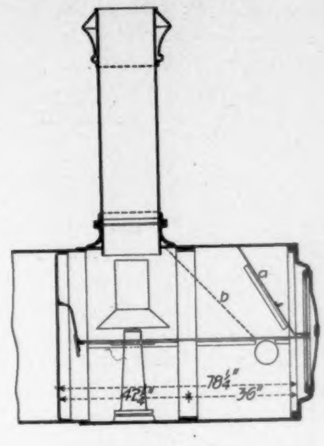


Fig. 7.

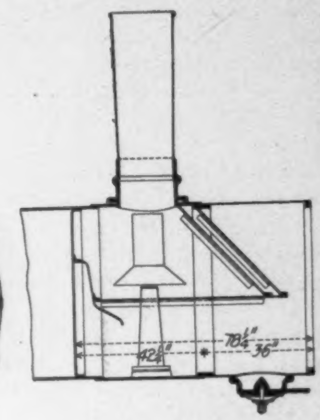


Fig. 8.

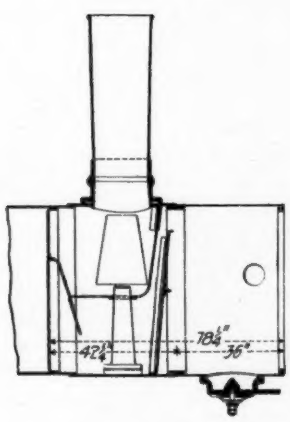


Fig. 9.

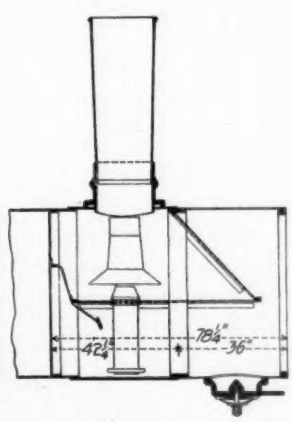


Fig. 10.

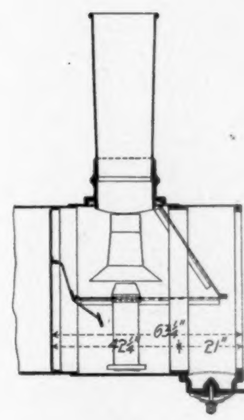


Fig. 11.

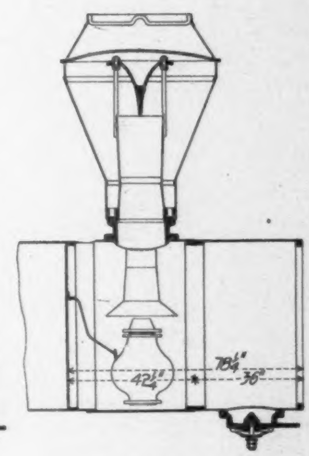


Fig. 12.

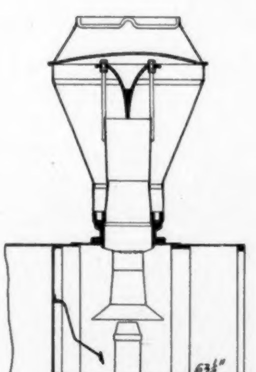


Fig. 13.

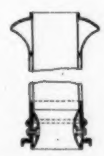


Fig. 14.

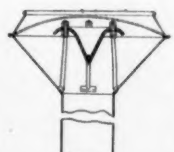


Fig. 15.

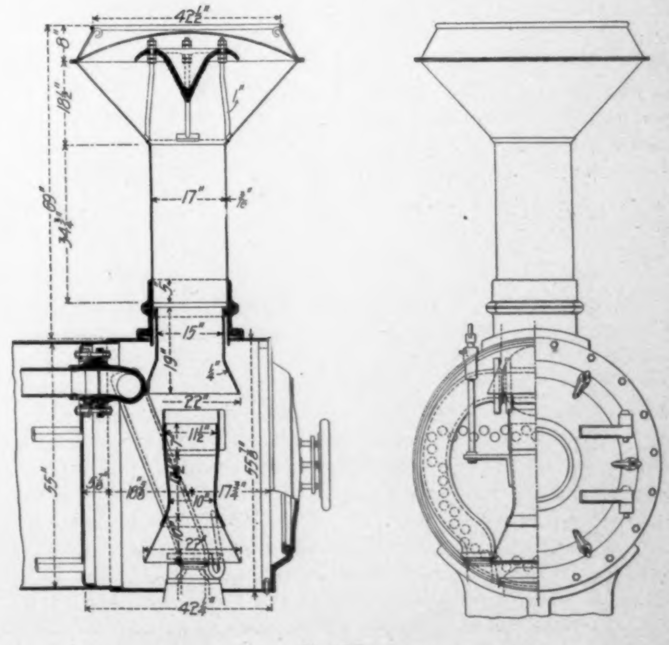


Fig. 16.
September, 1898.

tent at this time, but Fig. 15 indicated the return to the diamond pattern, now the standard form of the road. The present standard, including the low nozzles, petticoat pipe, stack extension and very short smoke-box, is presented in Fig. 16.

In order to understand Mr. McConnell's position in the matter of stacks it is necessary to consider the character of the coal used on that road. A great deal of it is lignite, which burns very much like wood, and the spark throwing is a serious matter. The appearance of the usual straight stack while burning this coal resembles that of the stream of sparks from the tail of a rocket, which renders the prospects of extensive prairie fires exceedingly promising. There is no reason to object to a return to former practice when the results justify it, and where diamond stacks work better than open ones, they should be used.

TRUCKS FOR 80,000-POUND CARS.

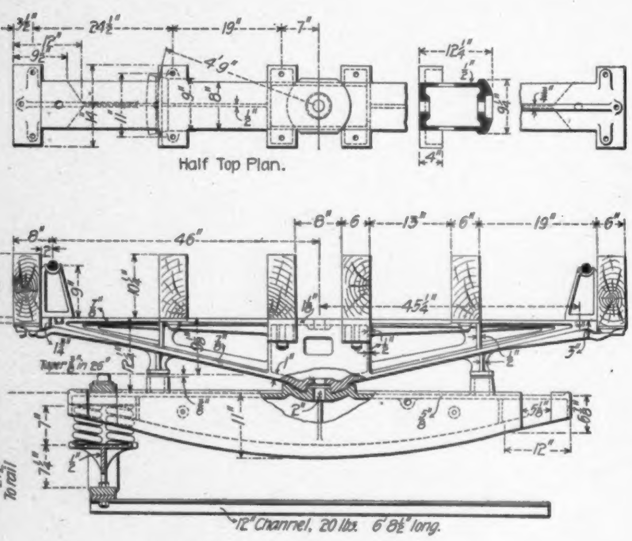
Cast Steel Truck and Body Bolsters.

Delaware & Hudson Canal Company.

Through the courtesy of Mr. R. C. Blackall, Superintendent of Machinery of the Delaware & Hudson Canal Company, we are enabled to illustrate the design of trucks with cast steel truck and body bolsters, used under a number of gondola cars of 80,000 pounds capacity.

This truck is of the arch bar type, with the column guides and spring seats combined in steel castings. The spring plank is in the form of a 12 by 20-inch channel. The whole arrangement was designed with a view of reducing the number of separate pieces to the minimum and at the same time to produce a structure that would be sufficiently strong to permit of carrying the load entirely upon the center plates. The bolsters and other steel castings were designed and furnished by the American Steel Foundry Company of Granite City, Illinois, and these parts are guaranteed to outlive the cars without excepting wrecks. They are giving satisfaction to the officers of the road, which is manifested by orders for large quantities. In describing similar trucks by these manufacturers for the Seaboard Air Line in our issue of September, 1898, we quoted from a letter received from Mr. W. T. Reed, Superintendent of Motive Power of that road, as follows:

"The idea of applying such bolsters to freight cars is to dispense with the many parts which require additional labor on trucks used previously of the same pattern as far as the arch bars were concerned, with flitch plate bolsters. . . . The time has now arrived when mechanics can readily see the advantages to be gained in the minimum number of pieces in any part of a truck or other machinery, and it is to this end that I find it most advantageous. What we need is a truck that will stand all abuses possible after derailments, so that the trucks may be replaced on the tracks and continue their journey, while others must be taken apart."



Cast Steel Truck and Body Bolsters.
Delaware & Hudson Canal Company.

The reason why English locomotive builders have not captured and held the locomotive business for South America, Africa and other fields, against American competition, is stated by "The Engineer" to be that the builders "insisted on supplying, so to speak, chronometers, when a 'Waterbury' was the thing wanted." In other words the English locomotive is too good a machine to be run on ordinary railroads.

IMPROVEMENTS IN BOILER MATERIAL.

Improvements in steam engine practice in the direction of higher steam pressures have caused equally marked advances in boiler construction, and particularly in the quality of the materials, without which higher pressures would be dangerous and entirely impracticable. About 20 years ago pressures rose from 50 to 100 pounds, and since that time the water-tube boiler has brought about the use of 250 pounds, reduced to 200 pounds at the engines. This development and the improvements in materials which rendered it possible, are discussed in a valuable paper printed in the "Journal of the American Society of Naval Engineers."

The general reliability and uniformity of mild steel has been an important factor in this progress. This is due chiefly to the fact that purchasers of boiler material have insisted that it must meet severe requirements, and the thorough inspection and tests of the Bureau of Steam Engineering of the Navy Department has exerted powerful influences in this direction. Nickel steel commands a great deal of attention for braces and rivets may be made with a tensile strength of 75,000 pounds and an elastic limit of 40,000 pounds. This means that smaller rivets may be used and the strength of joints increased by reason of cutting away less material for the rivet holes. The strength, toughness and uniformity renders nickel steel particularly desirable for braces and rods. An example illustrated in the paper is spoken of as being as tough as steel can be made. It is very uniform and exceedingly reliable. When subjected to a drop test it tears a grain at a time, holding together during many blows after fracture. In several cases where bars 4 inches in diameter, of this composition (carbon 0.23, sulphur 0.017, manganese 0.61, nickel 3.22 and phosphorus 0.021, with average tensile strength over 80,000 pounds, and elastic limit over 55,000 pounds, and an elongation of more than 23 per cent. in 8 inches) have been tested under a 1,640-pound weight, dropping 44 feet, the bars being supported at the ends and turned over after every blow, it required 40 blows to cause the first fracture and 40 more to complete the break.

Comparisons between the requirements of the material by the Bureau of Steam Engineering in the boilers of the "Maine," built in 1888, and those for torpedo boats, monitors and battleships commenced in 1898, give an excellent idea of the progress that has been made. Ten years ago shell plates were required to have tensile strength between 58,000 and 67,000 pounds, an elastic limit of 32,000 pounds and elongation of 22 per cent. To-day the requirements are: Tensile strength, 74,000 to 82,000 pounds; elastic limit, 40,000 pounds; and elongation, 21 per cent. In 1888 rivets and stays were required to have a tensile strength of 50,000 to 58,000 pounds, and now they must have 75,000 to 85,000, and other properties in proportion.

The increased steam pressures require corresponding increase in the care and watchfulness, steel having been improved sufficiently to be generally used. The pipe in present use is nearly all steel, and lap welded. It is made so well that flanges can be turned cold without causing cracks or flaws. Seamless drawn pipe is also used, and flanges are welded to their ends, the most recent development in this direction being the upsetting of the ends of the tubes and forming the ends themselves into flanges that are integral parts of the tubes. Wrought steel pipe fittings are also available for steam pipes, and it is clear that the boiler, through the increase of steam pressure, is recognized as the vital factor in the cheapening of the cost of power.

Selected timber to the extent of 950,000 feet, board measure, was shipped to the German Government from San Francisco recently for use in the new war vessels. The pieces were from 24 to 54 feet long and 4 by 4 feet in section. They were absolutely free from knots and blemishes and cost 4.66 cents per foot, as compared with 2.75 cents per foot in the same market for ordinary lumber.

THE RESIGNATION OF WM. BUCHANAN, SUPERINTENDENT OF ROLLING STOCK OF THE NEW YORK CENTRAL RAILROAD.

Rumor has been busy for some months past with reference to the retirement of Mr. Buchanan from the position on the New York Central Railroad, which he has so long and honorably filled. The rumor was not credited by those who knew him well, but on April 22 it was announced that his resignation had been sent in and accepted by the Board of Directors. At that time probably only a very few of those most nearly associated with him knew of his intention to retire from active work.

He was born in Scotland on March 6, 1830, and is therefore in his seventieth year. His service with the New York Central Railroad began in September, 1849, and he has been in the employ of the company ever since, so that in a few months more he would have completed fifty years of continuous service.

His father was a blacksmith by trade, and after coming to this country was employed in the Burden Iron Works in Troy. His son William obtained work in the same establishment, where he was first employed in punching the old-fashioned railroad chair plates. Later he worked with his father in the blacksmith trade. Being ambitious to learn the machine business, the son left the Burden Works and obtained employment on the old Albany & Schenectady Railroad, now a part of the New York Central line. He remained there about two years and a half, when, as he said, he concluded that no career was open to him there, and he determined to try his fortune in New York. After drawing his pay and paying his debts and his fare to New York, he had $1.25 left, with which he arrived in this city, which presumably was not as wicked then as it is now, or his capital of $1.25 would not have gone as far as it did. He at once applied for employment at the shops of the Hudson River Railroad at the foot of West Thirtieth Street. These shops were then under the charge of Walter McQueen, who afterward became the head of the mechanical department of the Schenectady Locomotive Works. When Mr. McQueen learned where young Buchanan had been employed he asked him whether he could set the valves of a locomotive. "Our man," Mr. McQueen said, "has been trying for four days to set them on one of our locomotives, and they are not set yet." Buchanan said he had done that kind of work on the Albany & Schenectady road and thought he could do it in New York. He was then placed in charge of the work and in about three or four hours had the valves properly set. It must be remembered that in those days "setting valves" was considered a great mystery. His success in doing this work was his first start on the Hudson River—now part of the New York Central—Railroad, and, as before stated, he has remained in the employ of the same company or its successors ever since. Soon afterward he was made shop foreman.

When Mr. McQueen left the Hudson River Railroad to take charge of the Schenectady Locomotive Works he was succeeded by Mr. Waterman. A disagreement between him and Mr. Buchanan led the latter to ask for employment running a locomotive. He was engaged in that occupation long enough to become thoroughly familiar with the practical part of the management of locomotives, and this experience was of very great value to him all through his career.

Waterman being of an inventive turn of mind, and like many other inventors often more sanguine about the success of his inventions than his employers were, dissatisfaction on the part of the latter resulted and his resignation followed, and in 1853 Mr. Buchanan was asked to take charge of the Thirtieth Street shops as Master Mechanic. The scope of his authority was extended from time to time, and in 1881 he became Superintendent of Motive Power of the entire New York Central system. Subsequently the title of the position was changed to Superintendent of Motive Power and Rolling Stock, and some time afterward the West Shore line was leased by the New York Central, the machinery department of the leased line was also placed under Mr. Buchanan's jurisdiction.

In the departments over which he had direct supervision between 7,500 and 8,000 men are regularly employed. It is doubtful whether any railroad man in the country, having authority over an equal number of men, has commanded their respect, confidence and feeling of personal allegiance to the same extent that Mr. Buchanan has, and the news of his resignation has been learned by them with profound feelings of regret.

Besides an intimate practical knowledge with all the details of construction and operation of railroad machinery, during all his career he has shown a remarkable clear and unerring discernment of the merits of mechanical appliances. His name became known the world over from the celebrated locomotive, No. 999, exhibited at the Chicago World's Fair, and which he designed and had built in the shops of the New York Central Railroad at West Albany. In his early days on the Albany & Schenectady road he did more or less work on the old pioneer locomotive, De Witt Clinton. Aided by some old drawings, he had a duplicate of this machine and three of the old cars used on that road built, which were also exhibited in Chicago, and attracted a great deal of attention.

A marked characteristic of his mind is conservatism, and he always seemed to have an unerring judgment in deciding whether any mechanical appliance was entirely practicable or not, and in the administration of the affairs, in the department over which he has had control, he showed a remarkable amount of skill and ability in producing maximum results with a minimum of expenditure. The system of management of the machinery department of the New York Central line and that of the Pennsylvania road are in many respects totally different. If some competent person should acquaint himself thoroughly with each of the two systems and make an analysis and comparison of their respective merits and demerits, it would be a work of the utmost value to the railroad companies of the country.

Mr. Buchanan has earned a rest, but those who have been favored with his acquaintance and friendship may perhaps now experience the same feeling of perplexity that American people generally feel about our ex-Presidents—that of finding a worthy occupation for him during the remainder of his life, Mr. Buchanan, though somewhat overworked, is still vigorous, and it is quite certain that in the years that remain for him—and may they be many—he will realize the truth of Joubert's remark, that "the residue of human wisdom purified by old age is, perhaps, the best thing we possess." M. N. FORNEY.

LARGE DREDGE FOR RUSSIAN CANALS.

A very large dredge, built by the Société John Cockerill, at Seraing, Belgium, for the Russian government, at a cost of $559,700, is described by Consul Alfred A. Winslow, writing from Liege, as follows:

The dredge is constructed on the principle of the dredge Beta, in use in the Mississippi, but is very much larger, being able to remove 4,000 cubic yards of sand, gravel, clay, or similar material per hour to a distance of 700 feet. The earth is cut up and mixed with water by revolving trepans, until it is of a consistency that can readily be forced up by two powerful steam pumps of 1,428 horse power each.

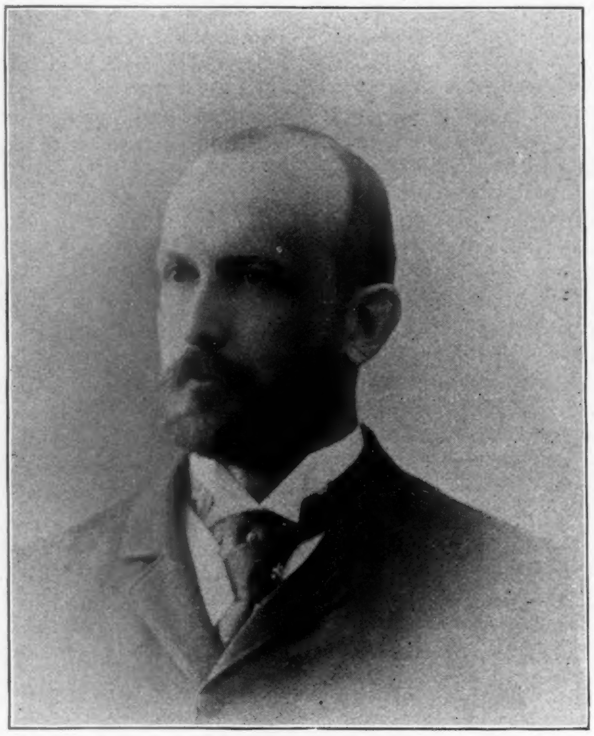
The dredge is 214 feet 6 inches long, 61 feet 6 inches wide, and when ready for work, draws 4 feet 6 inches of water. It can excavate a channel nearly 80 feet wide and 14 feet deep at one cutting. The fuel used is naphtha, and when the dredge is in full blast, it consumes about 1,200 gallons per hour. Tanks are provided that hold sufficient fuel to run the dredge at full pressure for twenty-four hours. When in full operation, it will give employment to 36 men, as follows: Stewards, 6; engineers, 12; and laborers, 18.

The dredge will be given a trial on the River Scheldt, near Antwerp, Belgium. From there it will be towed to the vicinity of St. Petersburg, where it will begin its work.

ARTHUR M. WAITT.

The appointment of Mr. Arthur M. Waitt to the position of Superintendent of Motive Power of the New York Central & Hudson River Railroad takes him from a leading position in charge of the car department of the Lake Shore & Michigan Southern to the first position in the motive power department of the Vanderbilt lines. He is in the prime of life, and has prepared for this important office by education, experience and most careful study of the problems of transportation which are constantly changing with the times.

He was born in Boston in 1858, and, after taking a degree in mechanical engineering at the Massachusetts Institute of Technology in 1879, he entered the service of the Chicago, Burlington & Quincy Railroad in the office of Mr. Thomas Potter at Burlington, and later served as draftsman in the car and locomotive departments until he entered the service of the Eastern Railroad at Boston in a similar capacity in 1882. In 1884 he became chief draftsman of the Eastern Railroad, and in 1887 was general foreman of the car department, and was soon appointed Assistant Master Car Builder of the Boston & Maine. In 1889 he was appointed Assistant Manager of the Pullman Works, but being broad and liberal-minded he could not confine himself long within the limits of a private car building establishment and left at the request of John Newell to return to railroad service as Assistant General Master Car Builder of the Lake Shore at Cleveland. In October, 1892, he was made General Master Car Builder, the position he now leaves.



ARTHUR M. WAITT,
Superintendent of Motive Power,
New York Central & Hudson River Railroad.

Mr. Waitt combines a technical engineering education with marked ability and experience. He is a clear-headed business man and has been closely identified with the best improvements in car construction. His chief work has been in connection with cars and by keeping constantly in touch with all motive power subjects he is well prepared for the problems now before him.

In 1898 he was elected Third Vice President of the Master Mechanics Association, and for years has taken a prominent part in the discussions before the Master Car Builders' Association. Before the technical railroad associations and in the technical press his opinions have been frequently expressed and while often bold, they have also been properly conservative. He is a member of the American Society of Mechanical Engineers.

He is a very clear thinker, a thorough organizer, a reliable mechanical officer, with opinions and reasons for them, and is an honest straight forward man, who gives a great deal of attention to the moral influences surrounding those for whose work he is responsible. He is a staunch supporter of the Railroad Branch of the Young Men's Christian Association, which has had such a powerful influence for good among the railroad employees of this country.

WIRELESS TELEGRAPHY.

At a recent meeting of the Institution of Civil Engineers held in London Signor Marconi read a paper on "Wireless Telegraphy," which has attracted unusual attention.

The lecturer began by describing the apparatus employed. In the course of his description he said that a properly made coherer, though the contrary had sometimes been stated, was as reliable as any other electrical instrument. He emphasized the great importance of the vertical conductor used in his system, and attributed the success he had obtained to its employment. He had found that the distance to which signals could be sent varied according to the square of the length of this conductor. Thus a conductor 80 feet high could be used for signalling over a distance of 18 miles, and he was confident that one 114 feet high would be sufficient to enable communication to be established between Folkestone and Boulogne, 32 miles apart. When such a vertical wire was employed no hindrance to the signalling was caused by hills and other obstacles or by the curvature of the earth.

As to the possibility of preventing messages sent by one station from being read by stations other than the one for which they were intended, Signor Marconi said that something could be done by the aid of syncronizing devices, two instruments not responding to each other unless properly tuned. By means of reflectors, too, an almost straight beam of electric rays could be directed in any desired direction, and he had found by experiment that at a distance of 1¾ mile a receiving instrument failed to act if it was more than 50 feet to the right or left of the supposed center line of the beam. This fact might, he suggested, be applied to the guidance of ships in thick weather. With reflectors he had not sent signals more than two miles, most of his attention having been given to the vertical wire system; but he was of opinion that it was possible to go much further in this way, and has since confirmed this.

He then proceeded to describe some of the installations of wireless telegraphy that had been successfully worked. Between Alum Bay and Bournemouth and later between Poole and Bournemouth—distances of 14 and 18 miles respectively—signals had been regularly exchanged, and the experience of 14 months showed that there was no kind of weather in England that could stop the working of the apparatus. Improvements in the construction of the instruments had enabled him to reduce the height of the vertical conductor to 70 feet for the distance between Poole and Bournemouth, and he expected to be able to make still further reductions. After referring to the installation set up between Ballycastle and Rathlin Island, and to the feat of reporting the progress of Kingstown regatta from a steamer accompanying the competing yachts, he went on to speak of the installation fitted up last autumn between the Royal Yacht Osborne and Osborne House during the Prince of Wales's illness. This gave an opportunity of studying the effect of intervening hills, and as the yacht moved about in various portions of the waters round the Isle of Wight doubts were set at rest as to the possibility of telegraphing across long stretches of land. Communication between lightships and the shore was a matter of great importance. The wireless system

had been in satisfactory operation since December between the South Foreland Lighthouse and the East Goodwin lightship—a distance of 12 miles—and had worked all through the recent storms without interruption, thus showing itself even more trustworthy than the land wires. As to wireless communication across the Channel, Signor Marconi said it would have been established long ago if the promised official consent of the French Government had been received, but information that this permission had been granted only reached him during the reading of his paper. [Since the paper was read the system has been successfully put into operation across the Channel between Folkestone and Boulogne.]

SHRINK AND FORCE FITS.

The relative merits of shrink and force fits have been considered uncertain and the difficulties of settling the question experimentally have rendered it a matter of experience and opinion upon which very little has been positively known.

The "American Machinist" of Feb. 16, contains an interesting article by Prof. J. J. Wilmore, of the Alabama Polytechnic Institute, on some experimental work of two Senior Class students in mechanical engineering, Messrs. Haralson and Wood. The experiments which formed the basis for their thesis, were made by forcing and shrinking steel spindles of nominally one-inch diameter, into cast iron disks, and noting the force required to pull some of them out, and to twist others in the holes. The holes were reamed to one-inch diameter, with an error believed not to exceed 0.00025 inch, while the spindles were ground to a diameter of 1.001, 1.0015, 1.002, 1.0025 and 1.003 inches. Below is given an abstract from the conclusions.

The following table shows the numerical results. It should be remembered that all the holes were one inch in diameter and one and one-fourth inches long, the variation in diameter being made in the spindle. It will be noted that the shrink fits are quite uniformly about three times as strong as the force fits of corresponding size, both in tension and torsion. The force fits were made without lubrication other than the small amount of machine oil adhering to the spindle on account of having been wiped with oily waste, after grinding, to prevent rusting. The spindles and holes were found to be smooth and in good condition after the tests. The maximum force was required to start the spindles. After movement had once occurred between the two surfaces, a much smaller force was required to start it a second time. No. 19 test piece was tried in torsion up to the limit of the scales without movement.

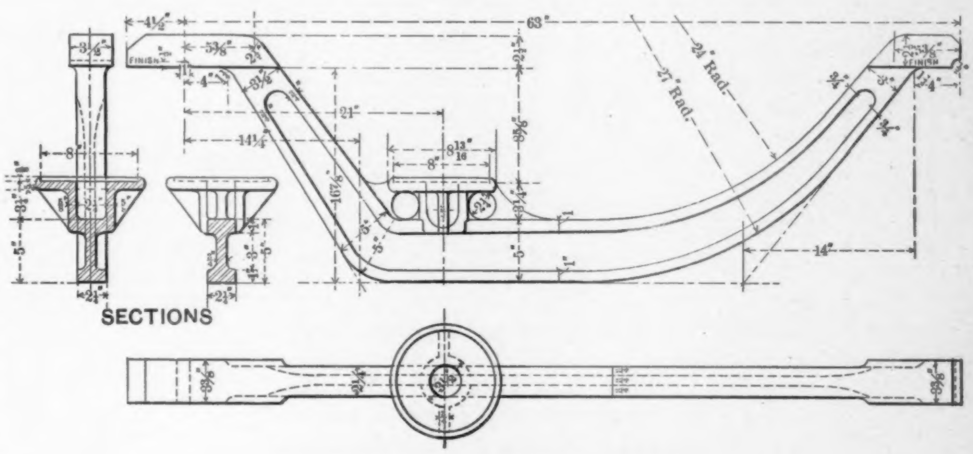
TABLE OF RESULTS.

Number of specimen.	Diameter of spindle. Inches.	Kind of joint.	Force necessary to start joint. Lbs.	Force per square inch. Lbs.	Kind of test.
1	1.001	Force.	1,000	318	Tension.
2	1.001	Shrink.	5,320	1,695	Tension.
3	1.001	Shrink.	5,820	1,853	Tension.
4	1.001	Shrink.	2,200	700	Torsion.
5	1.0015	Force.	2,150	685	Tension.
6	1.0015	Force.	2,200	700	Torsion.
7	1.0015	Force.	2,800	892	Torsion.
8	1.0015	Shrink.	7,200	2,290	Torsion.
9	1.0015	Shrink.	9,800	3,118	Torsion.
10	1.002	Force.	2,570	818	Tension.
11	1,002	Shrink.	7,500	2,385	Tension.
12	1,002	Shrink.	8,100	2,580	Tension.
13	1.002	Force.	4,200	1,335	Torsion.
14	1.0025	Force.	4,000	1,272	Tension.
15	1.0025	Shrink.	9,340	2,974	Tension.
16	1.0025	Shrink.	9,710	3,090	Tension.
17	1.0025	Force.	4,600	1,465	Torsion.
18	1.0025	Shrink.	13,800	4,395	Torsion.
19	1.003	Shrink.	17,000	5,410	Torsion.

The maximum tangential effort of 17,000 pounds obtained in the tests, would, with a coefficient of friction of 0.2, give a normal pressure of 85,000 pounds, or 27,070 pounds per square inch; a pressure well within the crushing strength of the metals employed. With greater difference between the diameter of spindle and hole, it might be necessary to force the spindle into a heated disk. It seems evident from these experiments that the shrink fit is the better of the two, but in practical work it is not always the best way, but the "good enough" way that is sought. If, therefore, the force fits are good enough and can be made more cheaply than shrink fits, they will be used in every case.

CAST STEEL EQUALIZERS FOR PASSENGER CAR TRUCKS.

The use of cast steel instead of wrought iron for passenger truck equalizers has been carried beyond the experimental stage by Mr. John Player, Superintendent of Machinery of the Atchison, Topeka & Santa Fe Railway, the design used on that road being shown in the accompanying engraving, which was made from a drawing furnished by Mr. Player of an equalizer for a six-wheel truck. The design was made to insure ample strength and with a view of obtaining satisfactory work in cast steel.



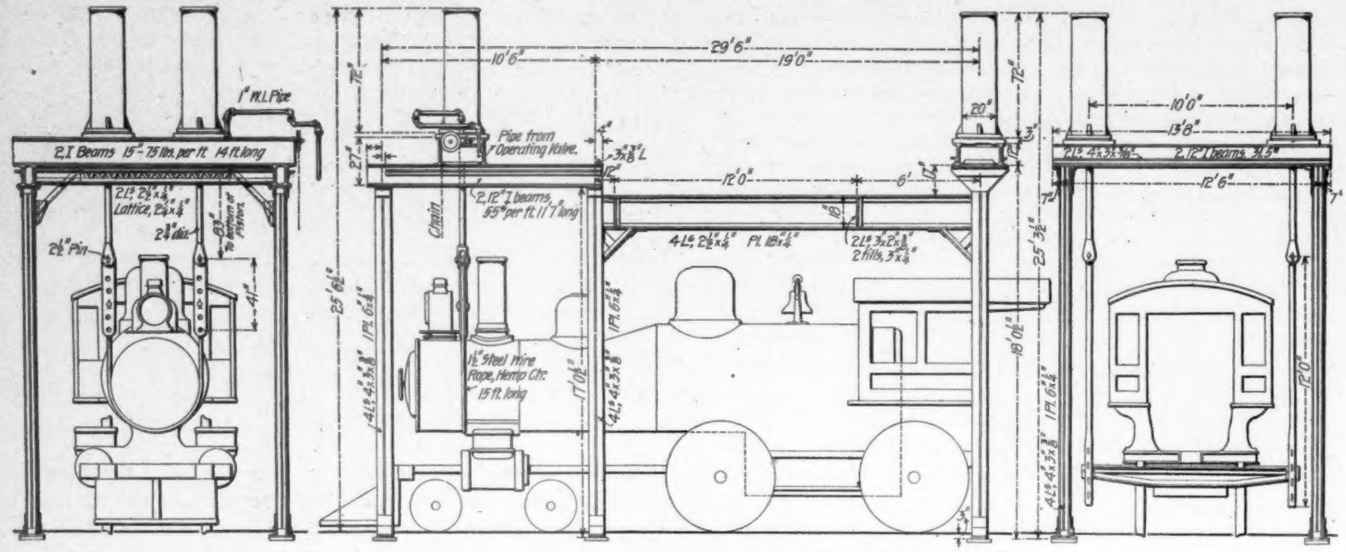
Cast Steel Equalizer for Passenger Cars.
Atchison, Topeka & Santa Fe Railway.

Except at the ends an I section is used, the web being ¾-in. thick, with the depth varying from 3 in. at the light end to 5 in. at the spring seat. The drawing shows the dimensions and the construction throughout.

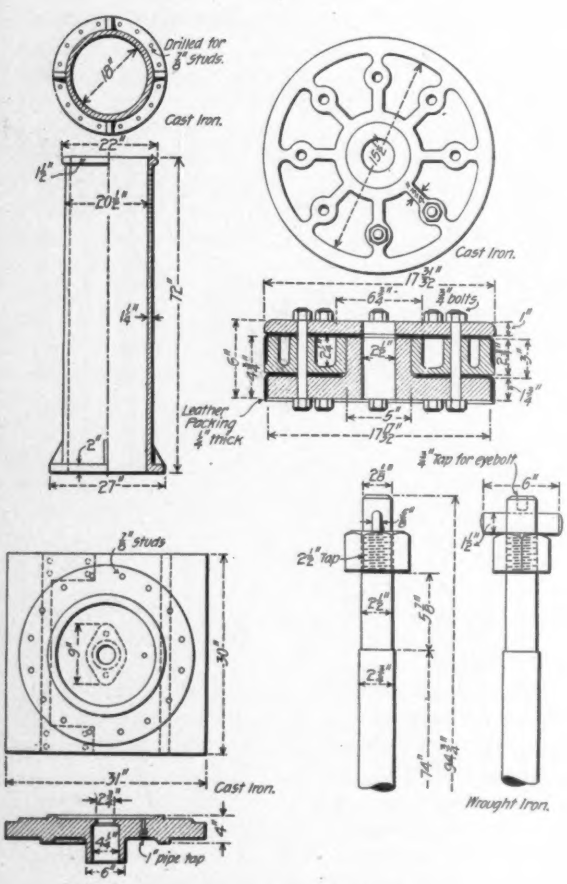
The equalizer as shown here was put into service in March of this year, after being submitted to severe tests in a testing machine, from which it appeared that the design was strong enough to stand the greatest load that they would be called upon to carry. They are now in use under eight heavy baggage cars, 60 ft. in length, and capable of carrying large loads, from which it appears that they are undergoing a severe test.

The chief advantages gained are less weight for strength equal to wrought iron, and a great saving in labor, due to absence of machine work. Mr. Player gives us the weight of this equalizer as 185 pounds, and of the equalizer spring seat 16 pounds, whereas the weight of the wrought iron equalizer which this one replaces was 210 pounds.

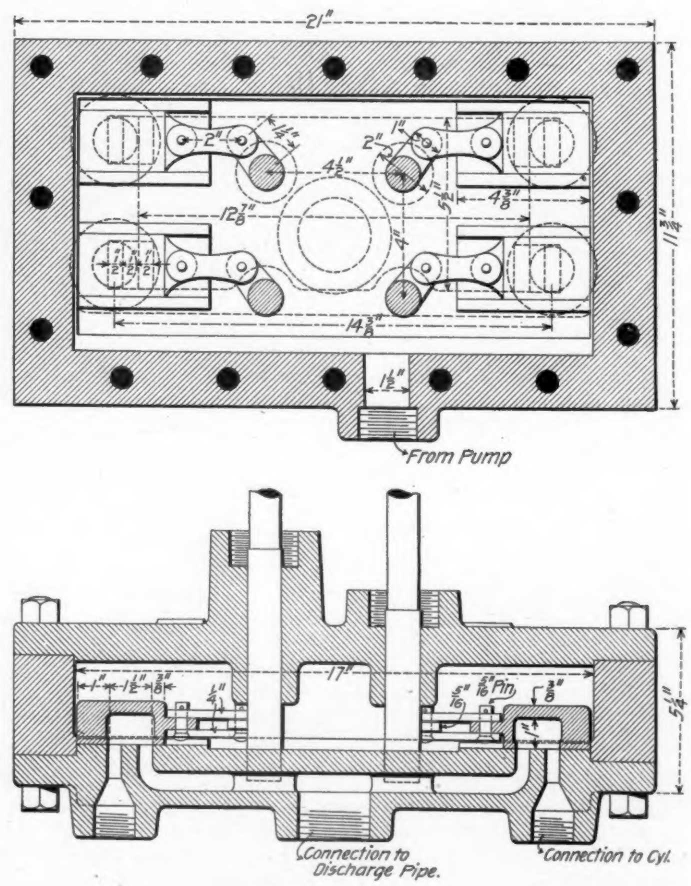
The Hyatt roller bearing has been awarded the Scott medal of the Franklin Institute. This bearing employs rollers in the form of spirally wound tubes, which are elastic. They do not break, and the committee reported a material reduction in the friction of the bearings by their use.



Hydraulic Locomotive Lift—Boston & Maine Railroad.



Cylinders and Pistons.



Operating Valve.

HYDRAULIC LOCOMOTIVE LIFT.

Boston & Maine Railroad.

A compact and inexpensive hydraulic lift for use in removing and replacing the driving wheels of locomotives recently built and installed at the Boston shops of the Boston & Maine Railroad is illustrated in the accompanying engravings. The object was to provide a hoist that would occupy the minimum floor space in an already over-crowded shop. The four hydraulic cylinders are mounted on a steel framework having six posts, the two cylinders at the rear end of the engine are fixed in position and are carried on transverse 12-inch I beams, while those for the front end are mounted on 15-inch cross beams and are arranged to move laterally on these beams by means of a chain wheel and screw shaft, while the cylinder bearers may be moved longitudinally along the short panel of the frame for adjustment to the length of the engines. A 1½-inch steel wire rope is used as a sling under the smoke box extension, each end being coupled to a link suspended from the piston rod of one of the cylinders. The rear end is lifted by means of a plate girder 10 feet 8 inches long, made of a 2 by 12-inch wrought iron plate, to which 5 by 3½ by ½-inch angles are riveted on one side only. This plate is 12 inches deep for a length of 50 inches at the center, and tapers to a depth of 8 inches at the

ends. The cylinders are of cast iron 1¼ inches thick, 18 inches inside diameter and 6 feet long. They are shown in section in the engraving, which also illustrates the construction of the cylinder heads and pistons. The piston rods hang from the pistons and are connected directly to the slings. The hydraulic connections to the forward cylinders are made by flexible piping with joints made like those illustrated in the "American Engineer" of November, 1898, page 376. Power is supplied by a duplex steam pump formerly used in a locomotive water station and capable of giving a pressure of 125 pounds per square inch in the lifting cylinders. With this pressure the hoist will raise weights of 50 tons and it is obvious that the capacity may be increased by using higher pressure. The controlling valve is a very simple arrangement of four small slide valves, one for each cylinder. The valve spindles are provided with stuffing boxes, not shown in the engraving. We are indebted to Mr. Henry Bartlett, Superintendent of Motive Power, for the drawings.

PERSONALS.

Mr. Herbert Roberts has been appointed Superintendent of Motive Power of the Norfolk & Southern R. R.

Mr. J. M. Robertson has been appointed Assistant Master Mechanic of the Wabash R. R. at Ashley, Ind.

Mr. S. Phipps has been appointed Assistant Master Mechanic of the Canadian Pacific at Winnipeg, Man. He was formerly Road Foreman.

Mr. John Vougt has been appointed Master Mechanic of the Mahanoy & Hazleton division, Lehigh Valley R. R., at Hazleton, Pa., succeeding Mr. F. Roth, resigned.

Mr. John Milliken, Assistant Engineer of Motive Power of the Philadelphia, Wilmington & Baltimore, has been appointed to a similar position on the United Railroads of New Jersey.

Mr. J. L. Mohun has been appointed to the position of Assistant Master Mechanic of the Juniata shops of the Pennsylvania Railroad at Altoona.

Mr. William Forsyth, Superintendent of Motive Power of the Northern Pacific, has resigned and will take a vacation for the benefit of his health.

Mr. R. W. Bayley, heretofore Assistant Secretary of the Westinghouse Air Brake Company, at Pittsburg, will succeed Mr. John W. Cloud as Western Representative in Chicago.

Mr. J. E. Button, Division Master Mechanic of the Chicago, Burlington & Quincy, at Ottumwa, Iowa, died March 13.

Mr. G. W. Dixon, heretofore Roadmaster of the Pittsburg, Lisbon & Western, has been appointed Master Mechanic of that road, with office at New Galilee, Pa., in place of Mr. Richard Beeson, resigned.

Mr. J. H. Pennington has been appointed Superintendent of Motive Power of the Delaware, Susquehanna & Schuylkill, with headquarters at Drifton, Pa., to succeed the late John R. Wagner.

Mr. L. F. Purtill, who for several years has been Mr. Parke's assistant as Eastern Representative of the Westinghouse Air Brake Company, will succeed Mr. Parke in charge of the New York office.

Mr. O. H. Crittendon, Assistant Engineer of Maintenance of Way of the Kansas City, Pittsburg & Gulf, has been appointed Chief Engineer of that system, with headquarters at Texarkana, Tex.

Mr. R. A. Parke, who for a number of years has been Eastern Representative of the Westinghouse Air Brake Company in New York, has been appointed Assistant Secretary, which will call him to Pittsburgh. He will be missed in New York.

Mr. O. J. Kelly has been appointed Division Master Mechanic of the Philadelphia, Baltimore and Valley divisions of the Baltimore & Ohio Railroad, with office at Riverside, Baltimore, Md.

Mr. Theodore Haberkorn, heretofore connected with the Motive Power Department of the Pittsburg, Fort Wayne & Chicago at Fort Wayne, Ind., has been appointed Master Mechanic of the Kenova shops of the Norfolk & Western.

Mr. S. M. Roberts has been appointed Acting Master Mechanic of the Brunswick & Western R. R. at Brunswick, Ga. He was formerly General Foreman of the Plant system at Waycross, Ga. He succeeds Mr. W. H. Dyer, transferred.

Mr. D. C. Moon, Superintendent of the Dunkirk Allegheny Valley & Pittsburg, has been appointed Superintendent of the Rome, Watertown & Ogdensburg, with headquarters at Watertown, N. Y., in place of Mr. E. G. Russell, resigned.

Mr. W. H. Stocks has been appointed Master Mechanic of the Chicago, Rock Island & Pacific, at Chicago, to succeed Mr. A. L. Studer, promoted. Mr. Stocks will be succeeded as Master Mechanic at Rock Island by Mr. R. D. Fiddler.

Mr. S. F. Forbes, Superintendent of the St. Paul shops of the Great Northern, has been appointed Purchasing Agent, with office at St. Paul, Minn., in place of Mr. J. W. Blabon, promoted.

Mr. A. L. Studer, formerly Master Mechanic of the Illinois division of the Chicago, Rock Island & Pacific, at Chicago, has been appointed Assistant Superintendent of Motive Power, to succeed Mr. J. W. Fitzgibbon. His office is at Horton, Kansas.

Mr. L. T. Canfield, formerly Master Car Builder of the Chicago, Rock Island & Pacific, at Chicago, has been appointed Master Car Builder of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa. He has had a wide experience and is well equipped for the position.

Mr. William Hutchinson, Master Mechanic of the Chicago & Northwestern, at Eagle Grove, Iowa, has been appointed Master Mechanic at Winona, Minn., to succeed Mr. William McIntosh, and is succeeded as Master Mechanic at Eagle Grove by Mr. J. F. Fleisher, Foreman of the shops at Winona.

Mr. Robert McKenna, who has been Master Car Builder of the Delaware, Lackawanna & Western since June, 1870, has resigned. He is 72 years of age and has been in railway service since March, 1853. He was for 17 years foreman of the car shops of the Hudson River Railroad before going to the D. L. & W.

Mr. Joseph Elder has resigned as Master Mechanic of the Rock Island & Peoria at Peoria, Ill. He has been in charge of the machinery and rolling stock of the road since 1877, and from 1871 to 1877 was Master Mechanic of the old Rockford, Rock Island & St. Louis, now a part of the Chicago, Burlington & Quincy.

Oliver H. De Young, Master Mechanic of the Galveston, Harrisburg & San Antonio Railroad, died recently at El Paso, Texas. Mr. De Young entered the railroad service in 1875 with the Texas & New Orleans.

Mr. W. N. Cox has been appointed Acting Master Mechanic of the Alabama Great Southern Railroad, succeeding C. Skinner of Birmingham, Ala., resigned.

Mr. G. W. Dixon has been appointed Master Mechanic of the Pittsburg, Lisbon & Western, with headquarters at New Galilee, Pa. He succeeds Mr. Richard Beeson, resigned.

Mr. E. H. Harriman, Chairman of the Executive Committee of the Union Pacific, and a member of the Board of Directors of the Illinois Central, has been elected President of the Chicago & Alton, to succeed Mr. T. B. Blackstone.

Mr. C. A. Seley has been appointed Mechanical Engineer of the Norfolk & Western Railway, to succeed Mr. G. R. Henderson. Mr. Seley has been connected with the mechanical department of the Chicago Great Western Railway for several years.

Mr. John Forster has been selected to succeed Mr. J. S. Turner as Superintendent of the Union Pacific, Denver & Gulf Railway at Denver. Mr. Forster was formerly Master Mechanic of the Atchison, Topeka & Santa Fe at La Junta, Col

Mr. H. W. Kimball, of the Cleveland City Forge & Iron Co., died March 9, at the age of 54 years, in Cleveland, Ohio. He was President of the Chapman Jack Co. and held an interest in the Butler Drawbar Attachment Co. He was a very successful business man, a great part of which was due to his unusual mechanical ability and farsightedness. His friendships were numerous and strong.

Mr. George W. Bartlett, Division Engineer, New York Central & Hudson River Railroad, has been appointed Superintendent of the Dunkirk, Allegheny Valley & Pittsburg, a part of the New York Central system, with office at Dunkirk, N. Y., to succeed Mr. D. C. Moon, who has been promoted. Mr. Bartlett's experience in the operating department has been wide and he is well equipped for the position.

The Pennsylvania Railroad Company has announced the appointment of the following engineers and assistants: Alex. Kearney, Assistant Engineer of Motive Power; D. N. Perine, Assistant Engineer of Motive Power of the Philadelphia and Erie and Northern Central; Jos. T. Wallis, Assistant Master Mechanic of the Meadows shops; L. T. Ford, Assistant Engineer of the Elmira-Canandaigua division on the Northern Central; S. Shober, Jr., Assistant Engineer of the Tyrone Division.

Mr. J. S. Turner, whose appointment as Superintendent of Motive Power of the Union Pacific, Denver & Gulf Railway, now known as the Colorado Southern, at Denver, was noted in our December issue of last year, has resigned that position to become Superintendent of Motive Power of the Fitchburg Railroad, with headquarters in Boston. His jurisdiction will extend over all matters pertaining to the locomotive department. Mr. Turner was formerly Superintendent of Motive Power of the West Virginia Central & Pittsburg, and began his railroad service on the Pennsylvania at Altoona. He is well fitted both in ability and experience for his new position, and the appointment is heartily commended.

Mr. John W. Cloud's resignation as Western Representative of the Westinghouse Air Brake Co., at Chicago, was announced after we had gone to press last month. He goes to London in the interests of the Westinghouse brake and we understand that he will be permanently located there. We can not think of any one who will be more generally missed than Mr. Cloud. For ten years he has been Secretary of the Master Car Builders' Association, and for four years of the Master Mechanics' Association also. His place in these organizations can not be as well filled by any one else. From a somewhat selfish point of view it is to be regretted that his abilities take him elsewhere.

Mr. T. B. Blackstone has retired from the Presidency of the Chicago & Alton on account of the rule of the road. He was elected President of the road in 1864 and has held the position continuously. His railroad work began in 1847, on the New York & New Haven road, as a rodman. From October, 1848, to December, 1849, he was Assistant Engineer on the survey and construction of the Stockbridge & Pittsfield, and from the latter date to April, 1851, Assistant Engineer of the Vermont Valley. He then came west and accepted the position of Division Engineer of the Illinois Central, which he held until December, 1855. He was made Chief Engineer of the Joliet & Chicago in 1856, and had charge of the construction of that road and its maintenance after completion, being chosen President in January, 1861. This road was absorbed by the Chicago & Alton, and Mr. Blackstone was chosen President of the latter in April, 1864.

Mr. Walter Katté who has been Chief Engineer of the New York Central & Hudson River Railroad for the past thirteen years, has resigned and will serve as Consulting Engineer. He was born in London in 1830 and prepared for the engineering profession in an engineer's office in England. Since 1850 he has been in railroad and allied service and has made an enviable record. Among the roads that he has been connected with are the Pennsylvania, the Central of New Jersey, the West Shore, the New York, Ontario & Western, and the New York Elevated, as well as the New York Central. In addition to his railroad work he has had charge of the western business of the Keystone Bridge Company for ten years ending in 1875, and he superintended the construction of the Eads Bridge at St. Louis. For six years he was Chief Engineer of the West Shore, including the period of its construction. Mr. Katté is widely known and has had a remarkable career in connection with very large engineering undertakings.

Mr. W. J. Wilgus has been appointed to succeed Mr. Walter Katté as Chief Engineer of the New York Central & Hudson River Railroad. He is thirty-three years of age and though a young man he is fitted by a wide and varied experience for this important position. He was born in Buffalo, New York, in 1865, and after securing a school education he spent two years in the study of engineering. In 1895 he entered the service of the Minnesota & Northwestern as rodman, and after five years he went to Kansas City, in charge of important work in connection with the terminals at that point. In 1891 he went to Chicago in the capacity of Resident Engineer of the Chicago Union Transfer Railroad, and in 1893 he entered the service of the New York Central as Assistant Engineer, Maintenance of Way of the Rome, Watertown & Ogdensburg. Since that time he has held important positions in the engineering department, under Mr. Katté, and is now, as Chief Engineer, placed in charge of construction and maintenance of way of all the New York Central lines.

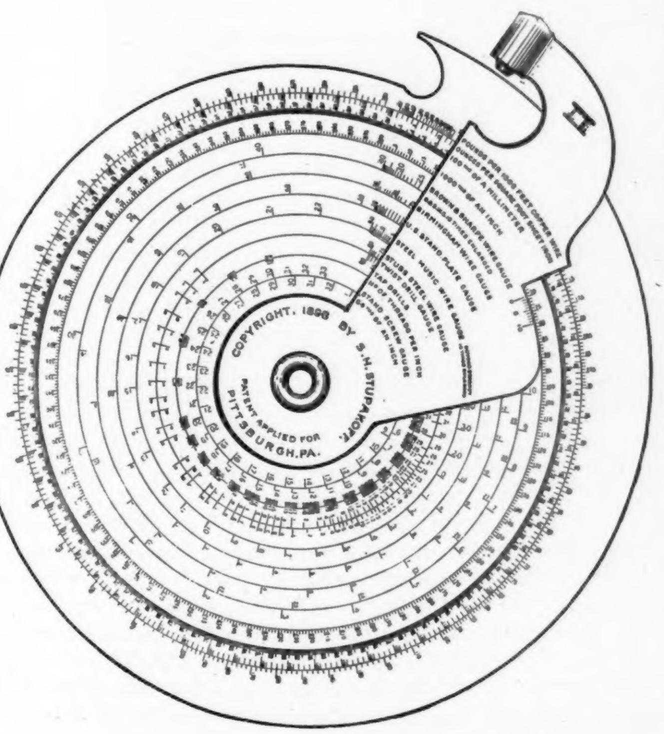
The American Society of Mechanical Engineers will hold its 39th meeting at Washington, D. C., May 9th to 12th, at the Arlington Hotel Assembly Room. The list of papers is as follows: "Standards for Direct Connected Generating Sets," by J. B. Stanwood; "Boiler and Furnace Efficiencies," by R. S. Hale; "Test of a Steam Separator," by F. L. Emory; "Investigations of Boiler Explosions," by G. C. Henning; "Equipment of Tall Office Buildings," by R. P. Bolton; "Heating Plant of University of Wisconsin," by Storm Bull; "Power Plant of a University," by E. A. Darling; "Plunger Elevators," by G. I. Alden; "Elevators," by C. R. Pratt; "Allen Valves for Locomotives," by C. H. Quereau; "Rolling Mill Fly Wheels," by John Fritz; "Valves for Steam Engines," by F. W. Gordon; "Manufacture of Car Wheels," by G. R. Henderson; "Belt Tensions," by F. L. Emory; "Tests of Fire Hydrants," by C. L. Newcomb; "Deep Well Pump Rods," by G. W. Bissell; "Pipe Flanges and Bolts," by A. F. Nagle.

STUPAKOFF'S COMPAROMETER.

A brief description of an ingenious measuring instrument devised by Mr. S. H. Stupakoff, Superintendent of the Union Switch & Signal Co., Swissvale, Pa., known as Stupakoff's Comparometer, was given in our issue of April, 1898. We are now enabled to illustrate and describe it more fully.

The comparometer combines a micrometer caliper, of English and metric division, with various current gauges for wire, plate, drills, etc.; it gives the weights for round and sheet metals, the number of threads per inch for standard machine screws and suitable tap-drills therefor, and furnishes the means for comparing any or all of these data at a glance. The mechanical principle involved in the comparometer is that of a plane spiral base combined with a radius vector, movable around its pole. A shifting of the radius vector causes some fixed point on it to recede from or to advance toward the spiral. The rate of recession or advancement is in direct proportion to the arc traversed.

The pitch of the spiral in this instrument is one-half inch, and the space between the circumference of the base and the adjusting screw of the radius vector or indicator arm gives an equivalent range of measurement. The readings corresponding to the absolute measurements of the comparometer caliper are tabulated on the base, and they are found, in each instance, in a radial line with the micrometer screw along the beveled edge of the indicator arm. The latter bears the descriptions for the divisions on the base and a vernier for the inch scale. The indicator arm is equipped with an adjusting screw in the same plane with the spiral edge of the base, and at right angles to its tangent.



Stupakoff's Comparometer.

The divisions on the base are described on the indicator; they represent in all cases a limit between 0 and ½ inch for the whole revolution. All numbers relating to the divisions on the base are marked above their respective division lines, which facilitates their reading without shifting the indicator.

The Brown & Sharpe wire gauge circle is provided with double divisions. The divisions on the outside of the circle are in direct proportion to the inch and the metric circle. The divisions on the inside, however, are tenfold enlargements of the former; they add, therefore, another decimal to the inch and metric scales, when compared therewith.

The steel music wire gauge, representing numbers from 8-0 to 30, and ranging in size from .0083 to .080 inch, is located on the fourth smallest circle. Its readings on the first portion of the circle, which are connected by a bracket, may be directly compared with any of the other gauges or scales on the dial. The reading on the inch circle, compared therewith, will give, therefore, dimensions in three decimal places, the fourth one being found with the aid of the vernier.

The Stubbs steel wire and the twist drill gauges, being nearly alike, are marked on one common circle, the one outside and the other inside of the same. The gauge lines and numbers of the American standard screw gauge are placed on the outside of the smallest circle; their corresponding dimensions or diameters are found radially in line therewith on either one of the scale circles; the number of threads to the inch and number of tap drills occupy the space on both sides of the next to the smallest circle. The notations on the inside of the smallest circle give the relative values of the above dimensions in 64ths of an inch. Those outside of the outside circle give the weight of 1,000 feet of copper wire in pounds; while those on the inside of the same circle give the weight in ounces for each square foot of sheet iron. Its use may be illustrated by the following example:

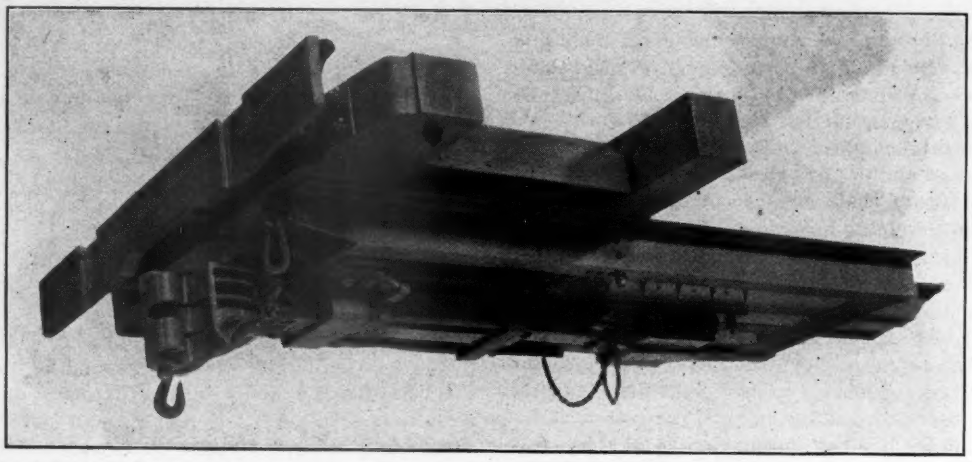
Assuming that a piece of copper wire is specified to measure 0.508 mm. The straight edge of the indicator is brought in alignment with this value, whereupon all the corresponding values are found along the radial line, which is indicated by the straight edge on the base. These are as follows:

.508 mm.
= .020 inches.
= No. 25 B. W. G.
= No. 24 (-.0001 in.) Brown & Sharpe Wire Gauge.
= 75 Stubbs steel wire and twist drill gauge.
= No. 5 (-.0002 in.) Steel music wire gauge.
= 1.24 lb per 1,000ft. (copper wire).

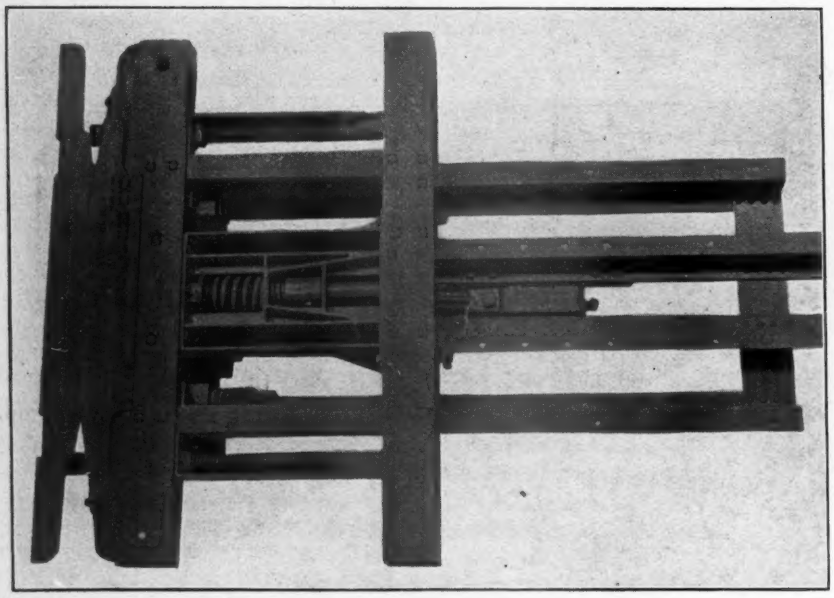
Assuming that we have a piece of copper wire concerning which all possible data is required. It measures No. 4 B. & S. wire gauge and the simultaneous readings are:

13-64 inch.
No. 11 standard machine screw.
24, 28 or 30 threads per inch.
No. 21, 20 or 19 tap drill.
No. 26 twist drill gauge.
No. 5 Stubb's steel wire gauge.
No. 6 B. W. G.
0.2043 inch.
5.19 millimeters.
126½ lbs. per 1,000 feet (copper wire).

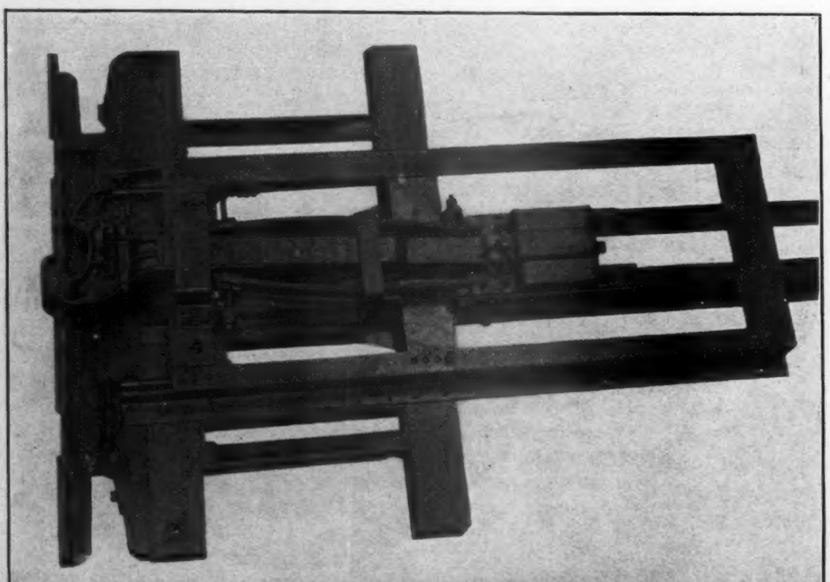
A statement of fuel costs on the Lake vessels, owned by the Cleveland-Cliffs Iron Company and used for transportating iron ore, is published by the Cleveland "Marine Review," and serves as some index to the low cost of transporting freight on the Great Lakes. These steamers are of moderate size and have not all the improvements introduced in the great freighters built during the past year, but the fuel cost on them seems extremely low. Thus, on one vessel, which made 26 round trips—32,866 miles in all, at an average speed of 10.05 miles an hour—the fuel cost was only 11.16 cents a mile. On another, which made 33 trips—41,009 miles in all—the cost was 11.86 cents a mile run. In this case the speed was a little higher, the average being 12.12 miles an hour. The average cost of fuel per ton-mile on these ships was 0.00279 cent and 0.002965 cent respectively. In both cases the fuel cost less than three one-thousandths of a cent per ton-mile. We do not believe that any such fuel costs can be shown anywhere else in the world, and yet on the Lakes they are called rather high. We may add that the average cost of coal on board was $1.89 a ton. We are assured that on the new boats carrying 7,000 to 8,000 tons, and furnished with quadruple expansion engines, much better results can be secured, and will be shown during the coming season.—"Engineering and Mining Journal."



The Gould Steel Platform for all Cars in Passenger Service.



The Gould Steel Platform—Top View.



The Gould Steel Platform—Bottom View.

THE GOULD STEEL PLATFORM.

A new steel platform recently perfected by the Gould Coupler Co. and adapted for use on cars with wide or narrow vestibules or without vestibules and also to baggage and express cars, is shown in these engravings.

Instead of I beams, Z beams are used in this construction, this selection having been made with a view of securing the greatest lateral stiffness. The upper flanges are turned toward the outside and the wide flanges offer good opportunities for fastenings. There are two central Z beams, outside of which are two shorter ones. These are well tied together by three steel plates, which are riveted to the lower flanges of the central Z beams and to the top faces of the lower flanges of the outside pair. The top flanges of the longitudinal members are tied together by their attachment to the platform and car sills. The draft gear is arranged to be removable without taking out any of the through bolts. The whole arrangement of the draft gear is such as to relieve the bolts from improper stresses. The bolts for the drawbar guides pass through the draft castings and also through the lower flanges of the central Z beams. The drawbar castings are of malleable iron and the flanges of the Z beams are protected by them from the wear of the followers.

The drawbar carry iron is held laterally by abutting against the lower flanges of the outside Z beams, which relieves the bolts from shearing stress. The steel beams are securely bolted to the end sills and also to the longitudinal sills. The buffing stresses are taken by a malleable iron buffing casting bolted to the top flanges of the center beams and fitted between the platform end sill and the end sill of the car. This forms a solid abutment to receive the compressive stresses and provides for them in a direct line where the resistance is greatest. This feature relieves the bolts and should have a marked influence on the life of the structure.

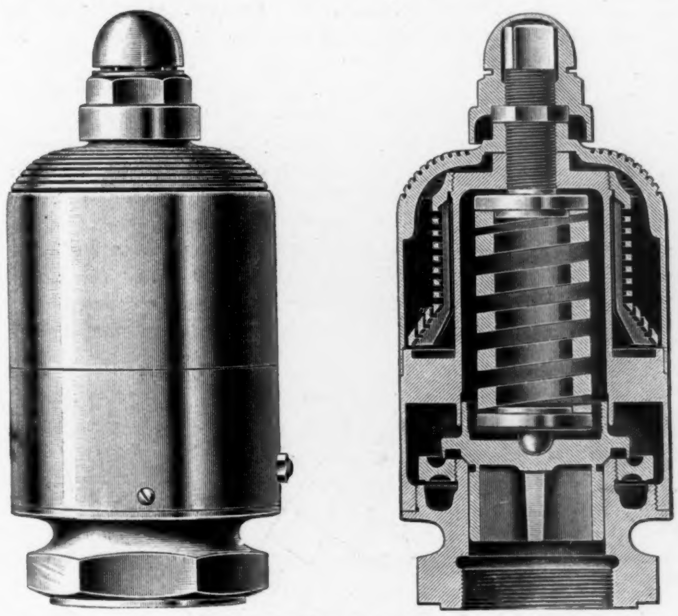
The platform is simple and easy of access, the parts likely to need removal being designed with this in view and also for easy inspection. It is adapted for use with the

Gould continuous buffer and coupler without changes and where these devices are now used with wooden platforms, these parts remain standard and are interchangeable with parts used with the steel platform. We are informed that this platform is no heavier than the corresponding parts of the Gould standard wooden platform. It is an important improvement especially considering its adaptability to so many different types of cars.

LOCOMOTIVE POP SAFETY VALVES.

Pop valves designed and made specially for locomotive use by the Star Brass Manufacturing Co., of Boston, are illustrated by the accompanying engravings, which show an exterior and a sectional view.

The section drawing gives a clear view of the construction of the valve, which is strong and heavy to withstand high pressures. The material, we are told, is of the best obtainable. The springs are made of the best grade of Jessop's steel, im-



Locomotive Pop Valves.

ported from Sheffield, England, specially for this purpose. They are made and tempered separately and are ground separately with a view of securing perfect work at the ends. They are thoroughly tested under high pressures before being placed in the casings, in order that any possible permanent set may be discovered before they are placed in service. The springs are fitted between pivoted spring discs, to prevent the valve from cocking or tilting. The spring is enclosed in a chamber and perfectly isolated from the escaping steam, which has a tendency to rust the spring and spoil its temper. The muffler is slotted, which is a novelty used in these valves only, and a feature that is considered by these manufacturers as the most perfect muffler to be found, and much better than the form in which the passages are round. A very large power of relief is also claimed as an important attribute of this design, to which the possibility of close adjustment of the range of "pop" while securing full relief of the boiler are added.

These valves are made in sizes from 2 to 3½ inches inclusive. Its adoption upon some of the most important railway systems is good evidence of merit. The address of the Star Brass Manufacturing Co. is 108 East Dedham St., Boston Mass.

The Wootten Boiler, Its Origin, Construction and Advantages, was the subject of a very interesting and instructive illustrated lecture by Mr. S. M. Vauclain, at the April meeting of the New York Railroad Club. The general use of this type of boiler was predicted, chiefly on account of its adaptability to the use of low grades of fuel. The large grate area was advantageous and increased the boiler power to a remarkable extent. The type was advocated in its improved forms.

THE PEARSON CAR REPLACING JACK.

This simple implement consists of two sockets swiveled to a pair of elongated sleeves which form nuts to receive a spindle having right and left hand threads and fitted with a ratchet which is operated by a lever. The success of the device is due to its efficiency and convenience. The jacks are very compact and very light in weight for the duty they perform. With them a car may be lifted and moved bodily, by placing them at an angle so that as they lift the car they also tend to push it in the desired direction; they are also used for replacing locomotives.

The introduction of these jacks was started in Boston, in November, 1897, on 32 railroads, and in one year the list grew to 125 roads, including the strongest and most progressive in the country. It has also been found necessary to establish a factory to make them in Canada, at Montreal. They are also in use in England, Germany, Russia, Japan, Australia, New Zealand, Mexico and the South American Republics. We have seen a number of letters from railroad men who have used them for locomotives and cars, which make it evident that they offer great advantages over the ordinary jacks for replacing rolling stock on the rails.

SUPERHEATING OF STEAM.

At a recent meeting of the Northern Society of Engineers, Mr. Paul Schou traced the history of superheated steam from the beginning and gave its later development in an interesting paper, of which the following is an extract:

Two serious losses follow the use of saturated steam, one of which is a limited range of temperature and the other is cylinder condensation. To reduce these losses two remedies are used; one of these is the steam jacket on the cylinder to raise its temperature, and the other to expand the steam in two or more cylinders, thereby reducing as much as possible the difference in temperature between the admission and exhaust steam. A third method may be used; namely, to superheat the steam so that (a) the ratio of sensible heat to total heat may be increased, and (b) considerable reduction of temperature may occur in the cylinder before reaching the point where condensation begins. Heat is transmitted from steam to water with such a rapidity that the late Mr. P. W. Willans was disposed to attribute the phenomenon of initial condensation almost entirely to the presence of water. Whether this theory is correct or not, the fact remains that the adoption of a high degree of superheat practically eliminates initial condensation. The exposed surfaces of iron remain and the steam is there as usual, but there is no water, for the simple reason that the walls of the cylinder are maintained hotter than the saturation temperature of the steam in contact with them. The practical effect of a and b taken together as follows:

A triple expansion engine, working with 180 pounds steam pressure, may, under favorable conditions, produce one horse power with 12½ pounds of steam. The same steam, superheated 150 degrees Cent, will, in a compound engine, produce one horse power with 8¾ pounds of steam. The initial saving in heat units is 22½ per cent., and it would be possible to get the same efficiency in a compound engine working with 11 atmospheres, pressure as in a quadruple expansion working with 25 atmospheres pressure. Superheated steam has another great advantage, in that its specific volume is greater than saturated steam of the same pressure. If there are, therefore, two cylinders of exactly the same size, both working with the same degree of expansion, the weight of steam will be less in the cylinder working the superheated steam. The volume increases in proportion to the superheat. The more the superheat, the less steam is used per horse power.

The total railroad mileage of the United States is said by Mr. Mulhall, an eminent English statistician, to be nearly half that of the entire world, there being 182,776 miles of railroad exclusive of side tracks in the United States, as against 436,240 miles as the world's total. The freight tonnage carried by our railroads is more than one-half that carried by the railroads of the world. The United States in 1892 carried 845,000,000 tons of freight 100 miles, as against 1,348,000,000 tons carried by the world the same distance, or 503,000,000 tons carried by the balance of the world.

THE BROWN PYROMETER.

Mr. Edward Brown, of Philadelphia, Pa., has devoted his attention for about 30 years to the manufacture of pyrometers and has sent us a brief review of the history of the use of these instruments, from which the following paragraphs are taken:

The original stationary pyrometer, having an appearance identical with those in common use to-day, was patented about 1850 in England. The stem was of metal, brass and iron. This style was made and sold in the United States, and though much overrated as to its suitability for high temperatures, it had considerable sale for bake ovens, and if inserted always to the same depth, was fairly accurate up to 600 degrees. It held its place as the only available instrument up to 1870. About this time the blast from iron stoves was much raised in temperature, occasionally running up to 1,000 degrees, and the demand was great for an indicator for this temperature. In 1870 Mr. Brown brought out his graphite stem pyrometer, which was still further improved in 1872 by making the inside rod of the stem above the graphite of the same metal as the stem, so that the stem could be inserted to varying depths and still indicate nearly accurately. This form of pyrometer soon became the only one in general use. With the advent of brick stoves producing a temperature up to 1,500 degrees, the most available instrument for many years was Brown's portable pyrometer, in which a mixture of hot and cold air imringed upon the expansion bar. An earlier instrument, Hobson's, on the same principle, in which the diluted blast was thrown aganist a thermometer, was generally used in England and the Southern States. Also Siemens' water pyrometer has been used to a considerable extent for temperatures up to 1,800 degrees.

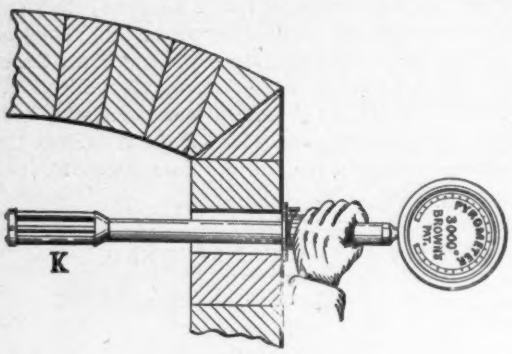


Fig. 1.

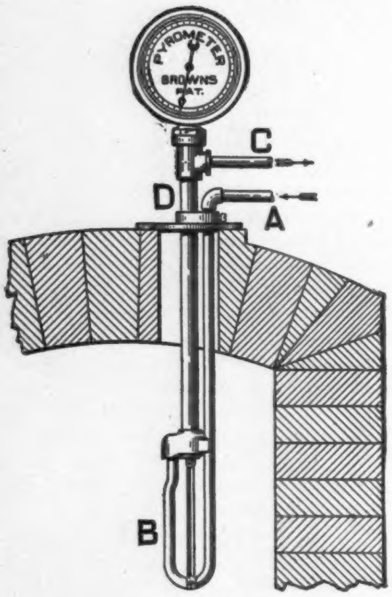


Fig. 2.

Mr. Brown's water current pyrometer came in 1895. It is easy to see from Fig. 2 how naturally one invention developed or evolved into the other. It only required the heavy solid frame K of the annealing oven pyrometer to be kept from melting off, and a stationary pyrometer to 3,000 degrees was accomplished. This was done by running a stream of water through it. This pyrometer must not be confounded with water current pyrometers, in which a pipe carrying a current of water is led through a furnace and the temperature of the water indicated by a thermometer. A prominent defect in all pyrometers based on the latter principle and usually overlooked is this: A current of heated gas or air at 2,000 degrees passing over a water pipe at a given draft of velocity, will heat it much hotter if passing at twice the velocity. Theoretically this must be the same with air curculating in place of water, though the error must be far less tnan with a liquid. This is provided for by Mr. Brown in the rod which passes from the expansion strip to the pointer. This rod takes its temperature from the water current, and serves to neutralize any error due to a rise or fall in the temperature of the frame D. The entrance for the water is at A. It flows through the bend B, up to D, and leaves the instrument at C. The indication needle is connected by a rod to the platinum expansion bar. This instrument is also made recording.

In 1896 Mr. Brown made his stationary hot blast pyrometer recording by means of special mechanism and clockwork. A pyrometer is subject to frequent handling, and it is important that the head, containing the recording chart, should be small and at the same time the degrees be large enough to indicate the fluctuations plainly. The indicating mechanism must also be so connected to the stem that the powerful expansion and contraction will not damage the delicate mechanism of the head. The accompanying chart shows how well this is carried out, only the degrees from 700 to 1,500 degrees are marked on the chart, this being the extreme of the range likely to be of service in blast furnace practice. These instruments are also useful for blast furnace downcomer pipe, and for recording the temperature of the escaping gas from steam boilers.

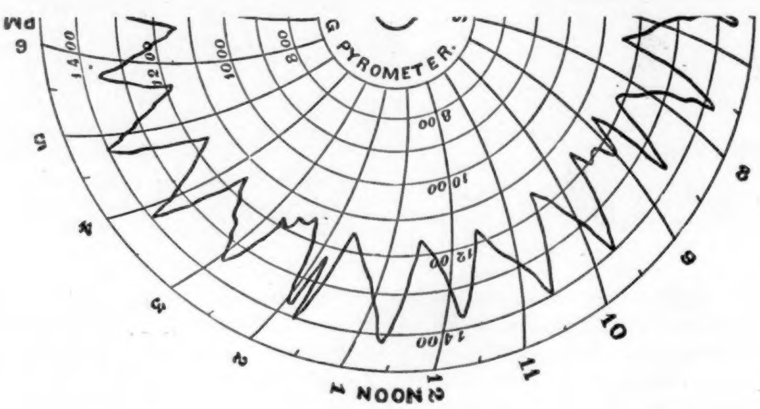


Fig. 3.

The value of recording devices is every year more appreciated. Instruments for this purpose have been for many years in extensive use, chiefly for steam pressures and low temperatures. We have only to go back perhaps 8 or 10 years to find the time when no recording chart was to be had of a temperature of 1,400 degrees. Fig. 3 shows a portion of a chart taken from a furnace probably without admixture of cold blast. The extremes of temperature are well defined. These charts indicate the exact time of changes of the furnace conditions. Their value in boiler tests is obvious.

Mr. Brown's pyrometers are all marked by great simplicity of construction, a very important feature when they are to be placed in the hands of ordinary workmen and laborers. The Franklin Institute of Philadelphia in 1897 awarded to Mr. Brown the John Scott Legacy Medal and Premium "for improvements in pyrometers." His address is 311 Walnut St., Philadelphia, Pa.

THE GRAHAM BRAKE EQUALIZER.

This device was designed to provide supports for the brake shoes of car trucks, in such a way as to carry the thrusts upon the journal boxes, instead of transmitting them to the truck frames, by means of hangers. The object was to prevent the tilting of the trucks and the sliding of the wheels. The brake hangers are attached to the ends of bent levers, which are fulcrumed in slotted lugs cast on the inside edges of the spring caps, and are provided with bearings on the inside edges of the top faces of the axle boxes. The end of one of these levers is shown in the engraving of a four-wheel passenger truck fitted with this equipment. This suspension relieves the truck frames from the stresses tending to tilt them, and the brake shoes therefore are maintained at a constant height with reference to the center of the wheel. There is a further advantage in this method in that the brake thrusts do not add to the loads on the forward springs of the trucks upon the application of the brakes.

Truck Equipped with Graham Brake Equalizer.

A severe service trial of this equipment was made recently under the direction of Mr. W. F. Stark, Superintendent and Joint Representative of the "Big Four," P., C. C. & St. L., Erie and Cincinnati, Hamilton & Dayton roads at Dayton, Ohio. We are informed that the device was applied for the purpose of preventing flat wheels, and that it was entirely successful. The trial took place on the Dayton & Union division of the "Big Four," between Dayton and Union City, a distance of 47 miles. There are 21 regular stops, and the time is 1 hour, 44 minutes for the trip. A round trip was made over this division with a baggage car and two coaches, fully equipped with the equalizers. The trip one way required 21 stops, of which one was a sharp one at a water tank, and in returning 25 stops were made. There were no cases of wheels sliding and not the least suggestion of a tilting movement of the trucks in the most severe stop. It is stated to be the intention of the road to continue and extend the use of the equipment. Four more cars are now in the shops to receive it.

Mr. J. Hector Graham, General Manager of the Safety Appliance Company, controlling the equalizer, states that in a test made on a baggage car when in a blinding snow storm, last March, it was shown to be impossible to slide the wheels, and he quotes from a letter from Mr. Stark concerning the device, as follows:

"So far it is giving satisfaction in preventing the dipping of the trucks, backlash of the train and sliding of the wheels."

THE PHILADELPHIA EXPOSITION.

The Philadelphia Commercial Museum and the Franklin Institute have planned an industrial exposition to be held in a new and appropriate building to be erected on the west bank of the Schuylkill and within easy access of the City Hall in Philadelphia. The object is to afford means for promoting international commerce and by exhibits of products and processes of manufacture to aid manufacturers and purchasers to come together for the discussion of topics of interest in international trade. The buildings provide more than eight acres of exhibition space. Light and power may be obtained from a power plant which is included. The exhibits will embrace foreign as well as home products, and the important subject of the proper method of packing and marking goods for foreign shipments is to be illustrated by aid of models. This is a more important matter than appears at first thought, because of the simple methods used in this country. When dealing with European and Asiatic countries, however, the customs requirements as well as the transportation facilities are very important. The success of the plan is promising, when the names of the following are found in the list of officers and directors: P. A. B. Widener, W. W. Foulkrod, John Birkinbine, W. P. Wilson, Edwin S. Cramp, Theo. N. Ely and Samuel Disston.

NELS' SEMAPHORE GLASSES.

The adoption of the Nels yellow glass for semaphore signal purposes by the New York, New Haven & Hartford Railroad has had the effect of directing attention to necessary improvements in signal glass as to strength, durability and uniformity of color. It is very important that signal lights should have most careful attention because of their responsibility in giving indications to the runners of fast trains, and yet it is common practice to purchase commercial glass, either red or green with no specification as to shade and usually samples are not even submitted. The glass is required to be "double thickness," but when cut from large sheets which are not uniform in thickness, the strength and the color varying considerably in discs that are cut from the same sheet. Good glass costs more than poor and when the cost of renewals and the insurance against accidents are considered it will certainly pay to use the best, especially in view of the increasing speeds of trains.

We have just received a set of standard colors from Messrs. Redding, Baird & Co., of Boston, the manufacturers of the yellow glass we noted last month, and find them admirable in every way, so far as inspection can show their qualities. The glass is ¼-in. thick and exceedingly strong. The studied irregularity of the surface is like that of the yellow and the reasons for this and also for the small lens surface cut in the center of each disc were fully stated on page 125 of our April issue.

The red disc is most interesting because instead of being coated on one side only with red, this glass has the red incorporated throughout the disc and it cannot peel or flake off. This feature is important in any system of colors but is most important on roads using white for an all-clear signal.

THE AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.

This association, which, by the way, has too long a name, was formed at Buffalo March 30, and the following officers were elected: President, Mr. John F. Wallace, Illinois Central; Vice-Presidents, Mr. P. A. Peterson, Canadian Pacific; W. G. Curtis, Southern Pacific; Treasurer, Mr. W. S. Dawley, Chicago & Eastern Illinois; Secretary, L. C. Fitch, Baltimore & Ohio South Western. The directors are prominent engineers and maintenance of way officers. It is an organization of officers engaged in the location, construction and maintenance of railways. The objects are to treat maintenance of way subjects by papers and discussions and to maintain a library. It is stated that a large amount of committee work will be done and that important subjects are to be placed in the hands of standing committees. The headquarters will be in Chicago and the annual meetings will be held in any city that shall be decided upon by vote. The association will probably be a most useful one. Its field is very important and its affairs are in the hands of very able men.

BOOKS AND PAMPHLETS.

Machine Design. By Forrest R. Jones, Professor of Machine Design, University of Wisconsin. Part I., Kinematics of Machinery. Price $1.50. Part II., Form Strength and Proportions of Parts. Price $3.00. John Wiley & Sons, New York, 1899.

Part I. has 165 pages, 8vo., and treats of the principles of mechanical motions, clearly and concisely. This is a good book for the use of students in taking up the fundamental motions of machine design. It is free from useless forms and seems to be very well written. It might have been put into the form of a preliminary part of the second volume with good effect.

Part II. is an exceedingly useful book. It differs from all other books on the subject in the large amount of very valuable data from large engineering firms, such as Fraser & Chalmers, The Baldwin Locomotive Works, E. P. Allis & Co., Lane & Bodley, and other equally well-known concerns. The design of important parts of engineering structures is presented in the abstract by examples and in mathematics. In addition to this the practice of these experienced firms is quoted where it is possible. It is one thing to be told how to design collar thrust bearings and quite another to be able to obtain a table showing the practice of the Newport News Shipbuilding Co., and to have the practice of the Marine Iron Works Co., of Chicago, in smaller work. The design of engine fly-wheels is made clear and comprehensive by abstract treatment, followed by such an example as the 25-ft. fly-wheel, weighing 160,000 lbs., made for the power station of the West Chicago Street Railway Co. by Messrs. Fraser & Chalmers, and a number of other important examples. No amount of discussion of the principles of the design of locomotive boiler seams could be as effective as the practice of the Baldwin Locomotive Works, illustrated in large, clear engravings. The book is admirable and the author shows that he appreciates the troubles of machine designers and he has probably learned, from experience, the value of good precedent as a support to calculations and theoretical designing. For example, one who has occasion to provide for forced fits will be very thankful to have several pages of data from the practice of successful machinery builders. The work is very well done, but it is not complete. The author should include other subjects, and probably will do so in future editions. If he does he will not only find a ready sale for the book, but will earn the thanks of many engineers and draftsmen. It can not be fairly compared with Unwin, but those who have the book under review will probably use Unwin less than before, and they will have the benefit of a great deal of information that has not been published, and this is of a character that has been guarded with scrupulous care by the manufacturers of machinery. The subjects considered are as follows: bearings and lubrication; spur and friction gears; belts and ropes for power transmission; screws for power transmission; screw gearing; screw fastenings; machine keys, pins, forced and shrinkage fits; axles, shafting and couplings; friction couplings and brakes; fly-wheels and pulleys; cylinders, tubing, pipes and pipe couplings; riveted joints; frames of punching, shearing and riveting machines, and selection of materials.

Boilers and Furnaces Considered in their Relation to Steam Engineering. By William M. Barr, Member A. S. M. E.; 405 pages. Illustrated. Philadelphia: 1899. J. B. Lippincott Co. Price $3.00.

This is a good book on stationary boiler design. It contains a great many examples of safe practice, and while it does not abound in startling, new ideas, it is full of carefully considered and well studied matter that boiler designers and users will find needful. It is not all original, as the author has reprinted extracts of papers and discussions and has included the conclusions derived from several reports that have been printed previously, but nothing has been copied that is available to the general reader who does not have access to the originals. As an illustration, comparatively few have the reports of the work done on the government testing machine at the Watertown Arsenal, and yet these contain probably the most valuable records of tests on riveted joints that have ever been printed. The author presents these and several extracts from the proceedings of the American Society of Mechanical Engineers; for example, Mr. Cole's paper giving the results of his very elaborate tests on stay bolts, and Whitham's conclusions on the subject of retarders in the tubes of steam boilers. The book was written because of the necessity for revising the author's previous work on "High Pressure Steam Boilers," which appeared 20 years ago. It is a book of construction detail, showing by a large number of engravings the latest and best practice in design. It includes more reliable and valuable data on riveted joints than we have seen anywhere, and for this alone the book will have a large sale. Its greatest value will be to the younger men in the profession, and especially to students. The book is thorough and it does not atempt to cover the entire subject of boilers. Marine and locomotive practice are to be treated in separate volumes, to appear later. It is thoughtfully and carefully written. The letter press and binding are excellent and the engravings are good. The book is the first of a steam engineering series by this author, each volume of which will be complete in itself.

Annual Report of the Board of Regents of the Smithsonian Institution. Government Printing Office, Washington, 1898.

This volume contains the usual reports of the progress made by the institution and its condition at the end of June, 1897. Following this 564 pages are given to appendixes which are unusually interesting in this report. They nearly all relate to scientific progress during 1897. Among them are: "Story of Experiments in Mechanical Flight," by S. P. Langley. The "Discovery of New Elements Within the Past 25 Years," by Clemens Winkler; "Letters from the Andree Party," "Life History Studies of Animals," by L. C. Miall; "Recent Research in Egypt," and the "Building of the Congressional Library in Washington."

Intercontinental Railway Commission Report.

This is a monumental public document which for completeness of plan and execution is admirable. It is a record, in seven large octavo volumes, including maps, of the work of this commission in their labors in surveying and exploring for the suggested Intercontinental Railway through Central and South America. This idea had its origin in 1821, when Simon Bolivar proposed a close connection between the Spanish colonies of Central and South America. After a number of congresses were held to consider the subject, a bill was proposed in the Congress of the United States in 1880 for the purpose of encouraging closer commercial relations between the United States, Mexico, the States of Central and South America. A law was passed in 1884 authorizing a traveling commission. Afterward delegates from 18 governments met and recommended the construction of an intercontinental railway, which resulted in the appointment of this commission, whose report we now have before us. Lieutenant R. M. G. Brown, U. S. N., was appointed executive officer, and Captain E. Z. Steever, U. S. A., secretary. Three corps of engineers were put into the field, one under the command of Capt. Steever, another under Mr. William F. Shunk, and the third under Mr. J. Imbrie Miller.

The results of their labors are recorded in the volumes published by the expense of the Government. Volume I. contains the report of Corps No. 1, relating to Guatemala, Salvador, Honduras, Nicaragua and part of Costa Rica; in Volume II. that of Corps No. 2, relating to Costa Rica, Colombia and part of Ecuador; Volume III., Corps No. 3, referring to Ecuador and Peru. Each report is supplemented by a separate volume of maps. The entire work is well planned and executed in every particular and engineers who are fortunate enough to secure copies of the report will find it a most instructive and valuable record which is a credit to the United States Government. The office of the Secretary, Captain E. Z. Steever, is 1317 F. street, N. W., Washington, D. C.

Massachusetts Institute of Technology. Annual Report of the President and Treasurer, 1898.

This report shows this school to be in a most satisfactory condition in every way.

Massachusetts Institute of Technology. Annual Catalogue, 1898-1899.

This catalogue gives the usual statements of courses of instruction and a register of the alumni.

"No. 25,000" is the title of a pamphlet received from the Ingersoll-Sergeant Drill Company, announcing the fact that the serial numbers given to the rock drills made by them have reached this large number. The pamphlet gives an idea, in graphic terms, of what this large output means. The firm is now able to turn out 1,800 of these machines per year.

Compound Locomotives.—The latest pamphlet, No. 11, of the series on locomotives regularly issued by the Baldwin Locomotive Works, contains a reprint of the proceedings of the St. Louis Railway Club, including the paper read by Prof. R. H. Smart, giving a record of the data taken by him from the Vauclain compound model locomotive at Purdue University. It also contains Mr. Vauclain's discussion of the paper before the same organization. Together, they constitute a valuable addition to the literature of the compound locomotive, with particular reference to high speeds, and many railroad officers will be glad to be able to preserve it in this convenient form.

The W. Dewees Wood Company, manufacturers of the well known patent planished sheet iron, smooth black sheet iron, and patent planished locomotive jacket iron, are soon to issue a handsome pamphlet illustrating and describing, with considerable attention to detail, their works and methods of manufacture. From the initial process of cutting wood for charcoal-pits to the final delivery of the finished product in the warehouses of the company, the various processes will be illustrated and described in sequence. The Chasmar-Winchell Press, of New York, are to print it, and their instructions are to spare no effort to turn out as handsome a work as is possible.

Shaw Electric Traveling Cranes is the title of a handsome book in boards recently issued by Messrs. Manning, Maxwell & Moore, 85 Liberty street, New York, in response to many requests for catalogues of cranes. The book illustrates thirty-five electric cranes built by the Shaw Electric Crane Co., Muskegon, Michigan, as installed in the largest and best known manufacturing establishments in the United States, as well as the Government gun and navy yard shops. The selection of subjects was made with reference to showing different principles of construction and operation and, incidentally, the book constitutes a study of modern improved shop arrangements in which it is made prominent that these large and successful manufacturing concerns consider it very important to provide the best facilities for handling heavy loads quickly, cheaply and conveniently. The catalogue contains instructions for ordering, a list of types and capacities, a diagram stating the information desired by the manufacturers in making estimates. Under the caption "General Remarks," an excellent discussion of the construction and operating mechanism of electric cranes is given. The book is one that should be in the library of every engineer and works manager, for it is the best book on modern cranes that we have seen. It should be consulted by the mechanical railroad officers, whether they are contemplating new shops or improvements in old ones. The engravings are good and the binding excellent.

"Four Track Series" No. 22. The New York Central & Hudson River Railroad, Mr. Geo. H. Daniels, General Passenger Agent, has issued a very atractive illustrated folder entitled "Saratoga, the Beautiful," which is numbered 22 in the "Four Track Series." It is a fitting addition to the fine collection of books gotten up by Mr. Daniels to give information concerning this railroad and is well worth sending for. Copies may be obtained by sending two 2-cent stamps to Mr. Daniels, Grand Central Station, New York. One of the features of the book is the description and illustration of the new train to be placed in service early this season by the New York Central, to be styled the "Saratoga Limited" which, it is said, will make as fast time as the "Empire State Express," reducing the time between New York and Saratoga from five hours to three and a half hours.

The Ingersoll-Sergeant Drill Co., 26 Cortlandt street, New York, have issued a little pamphlet containing a small engraving of each of its many types of air compressors, accompanied by brief descriptions of each. The many manufacturing interests with which compressed air is connected is presented in a striking way by a glance at this pamphlet.

EQUIPMENT AND MANUFACTURING NOTES.

The J. S. Toppan Co. have moved from the Temple Court Building Chicago, to the Great Northern Building in that city.

The headquarters of the National Electric Car Lighting Company in New York have been removed from 30 Broad street to 71 Broadway.

The Babcock & Wilcox Co. have received orders during the first three months of this year for as many boilers as they sold during the entire year 1895, and nearly as many as were sold during 1896.

The Leach locomotive sander was specified for attachment to the Schenectady compound consolidation, and also the mogul locomotives for the Southern Pacific, which are illustrated elsewhere in this issue.

The Chicago Grain Door has been ordered for the 500 cars which are now building by the Chicago, Milwaukee & St. Paul at its West Milwaukee shops, and also for 1,000 cars for the Chesapeake & Ohio, to be built at Pullman.

The Chinese Eastern Railway, which is a continuation of the Trans-Siberian line, has ordered 80,000 tons of steel rails of the Maryland Steel Works. The order is to be executed at Sparrows Point. It is expected that the first installment will be shipped early in May and that monthly shipments will follow.

A dozen or more of the 45 consolidation compound freight locomotives, recently ordered for use on the southwestern division of the Baltimore & Ohio Railroad, are in service, and are giving entire satisfaction. On the Mississippi division, they have increased the train haul 40% over the old line. When the grade reductions are completed the improvement will be even more noticeable. The compound ten-wheel passenger engines have developed unexpected pulling power and unusual speed.

The Chicago Pneumatic Tool Co. reports for the month of March the largest amount of business ever done in a similar time in its history. These orders are from many different concerns, including railroads, ship builders, manufacturing concerns and foundries. In foundry work they find extensive use in chipping castings and in drilling. The record for March, 1899 is considerably more than double that of the corresponding month of last year and the business for April is more than for March. April 11 orders were received for 158 pneumatic tools, including compressors, drills, hammers, riveters and other tools. They are going to people who are extending the use of compressed air and this increase in trade is a fair index of the condition of the business of the country.

The "Simplex" bolsters, which are illustrated in this issue as applied to the new cars for the Lake Shore & Michigan Southern and the Pittsburgh & Lake Erie Railways, are making rapid progress. Over 30,000 have been placed in service since the beginning of the current year. They have been specified recently for 200 box cars for the Missouri, Kansas & Texas, 2,000 coal cars of 80,000 pounds capacity for the Hocking Valley, 800 coal cars of like capacity for the Chesapeake & Ohio, and for the 500 coal cars for the Lake Shore.

Some time ago the Pullman Company, as an experimental measure, introduced "Ordinary" sleeping car service on the Baltimore & Ohio Railroad between Baltimore and Newark, and Pittsburg and Chicago. The results to the railroad company were very gratifying, but subsequently it was ascertained that the Pullman Company was not in position to furnish this class of equipment to all roads operating Pullman cars east of Chicago and St. Louis, and to allay any friction that might result from this inequality of service, the Pullman Company requested the Baltimore & Ohio Railroad to resume the standard cars previously in service, which has been done commencing April 10.

An Otto gas engine, operated by gasoline and furnishing about 20 horse-power, has been installed on the Hackensack drawbridge of the Erie Railroad. The change was made with a view of replacing the old steam engine with a more economical power which would avoid the inconvenience of handling coal and ashes on the busy main line bridge. The gasoline engine is started about a half minute before it is necessary to open the draw, and as it is stopped again immediately after closing the bridge, the fuel cost is very low, and there are no "stand by" losses. A steam engine, however, requires full working steam pressure the year around, and 24 hours every day. Drawbridge operation is almost an ideal field for the internal combustion engine. This plant was installed by the Otto Gas Engine Works of Philadelphia.

The Chicago Pneumatic Tool Company announces valuable acquisitions to their working force in securing the services of Messrs. J. W. Pressinger and J. M. Towle. Mr. Pressinger is well known to users of compressed air through his long connection with the Clayton Compressor Works, and he now leaves them to become connected with the New York office. Mr. Towle, who will open an office for this company in Boston, has been for the past ten or twelve years engaged in the manufacture and sale of pneumatic tools, and is an expert in that line, and is well known throughout the East, where his work had principally been done. With this arrangement the Chicago Pneumatic Tool Company will have offices in Chicago, Buffalo, New York, Boston, Pittsburg, St. Louis and San Francisco.

A pertinent point bearing on the "first cost" idea of jackets for locomotives is the fact that there is no locomotive builder in this country who does not, in the absence of instructions to the contrary, place Wood's patent planished iron on every locomotive built. It has never been demonstrated to the satisfaction of any real student that the first cost of painted jackets, leaving aside the question of constant renewal and the matter of appearance, is lower than that of patent planished iron. One would hardly lack temerity, were he to assert that locomotive builders are inferior to any railroad men as figurers on the question of relative cost. And the fact that there seems to be no question in the minds of locomotive builders carries its own conclusions.

The best method of protecting metal and wood surfaces by paints is a problem which is occupying a great deal of attention. The best means for determining the value of protective coverings is to examine the records obtained in service, and we have just received a communication from the Shearer-Peters Paint Co., of Cincinnati, Ohio, which contains so many favorable reports that we have reproduced it in part, as follows:

Mr. W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western Ry., says: "Up to the time of testing your paint the most durable covering we had tried on our locomotive front ends lasted only one week, really only about five days. At this time those painted with your paint have been run for five weeks, and are still all right. This result warrants us in placing an order for a considerable quantity of your goods." Later, Mr. Lewis writes: "The Shearer-Peters paint is the best we have ever used. We have adopted it as our standard for locomotive front ends, etc."

The Collins Park & Belt Railway of Atlanta, Ga., used this paint on the roof of their power house over two years ago. The roof was in an awful condition and it was thought necessary to put a new roof on at once. Mr. M. B. Carlton, General Manager of the road, writes under date of Jan. 20, 1899: "I had no idea Mr. Shearer could do the roof any good, but he certainly did, and during all this time the roof has not leaked."

"After thoroughly testing the Shearer-Peters paint on service pipe, retorts, holders, boiler fronts, etc., I am convinced that it is just the thing gas men have long sought for. It is far superior to any other paint I have ever used, and I believe it will sustain every claim the Shearer-Peters Company make for it. Respectfully, H. H. White, Supt. Portsmouth, Va., Gas Co."

Wm. H. Wood, of Media, Pa., hydraulic engineer and builder of special machinery, reports a large number of equipments which he has completed. He has very recently put in a complete hydraulic riveting plant for Thomas Kingsford, Oswego, N. Y., consisting of a 9 foot gap riveter to put a pressure on the rivets up to 75 tons; a 15 ton overhead crane, 10 inch by 12 foot accumulator, with hydraulic pump, complete. He has also furnished the Aultman & Taylor Machinery Co., of Mansfield, O., with his new patent cylinders for their hydraulic riveting machines. He has put in a hydraulic riveting plant for the McIlvain & Speigel Boiler & Tank Co., of Cincinnati, O., consisting of 9 foot riveter, 8 inch by 10 foot accumulator, and 8 ton crane, with hydraulic pump, complete. He has furnished this same company a 15 ton hand traveling crane having a span of 46 feet 9 inches, which can be operated by one man controling the full load; a similar plant for Borger Bros. & Co., of Columbus, O., and one for the Enterprise Boiler Co., of Youngstown, O.; also a 600 ton hydraulic press for the Fox Pressed Steel Equipment Co., of Joilet, Ill., and a 1,100 lbs. single standard steam hammer. He has also furnished the Du Bois Iron Works, of Du Bois, Pa., a hydraulic upsetting and forming machine; also hydraulic pump, accumulator, etc., all complete, as well as a hydraulic punch for punching 17 holes at one time, the outside holes to be punched 10 feet apart. He has supplied the same works with a 1,100 lbs. single standard steam hammer, and a 800 lbs. steam hammer of the same type for the Washington Navy Yard, Puget Sound, Washington. One complete hydraulic riveting plant for Orr & Sembower, of Reading, Pa., 9 feet 1 inch gap riveter, 8 ton crane, 8 inch by 10 foot accumulator and pump complete. Also a hydraulic pump for the Richmond Locomotive Works, of Richmond, Va., besides overhauling the entire hydraulic plant. He has furnished a 5 ton and a 10 ton hand traveling crane, 25 feet 6 inch span, for the Burlee Dry Dock Company, of Staten Island. He has shipped a 10 inch by 6 feet accumulator to the Buffalo City Gas Light Co., of Buffalo, N. Y., and two hydraulic riveting plants to Honolulu, the first of this class of machinery that has gone to the Hawaiian Islands, consisting of a 9 foot hydraulic riveting plant and a 6 foot hydraulic riveting plant, with overhead cranes, pumps and accumulators complete; also an air compressing and caulking plant. He has shipped an air compressing and caulking plant to the Kilby Manufacturing Co., of Cleveland, O., and a hydraulic flanging press to the Riverside Boiler Works, of Cambridgeport, Mass., besides other machinery and pumps to other parties, and is about to ship a complete hydraulic riveting plant to Canada, upon which a heavy tariff duty will have to be paid. This entire list speaks well for Mr. Wood's reputation for building satisfactory machinery.
